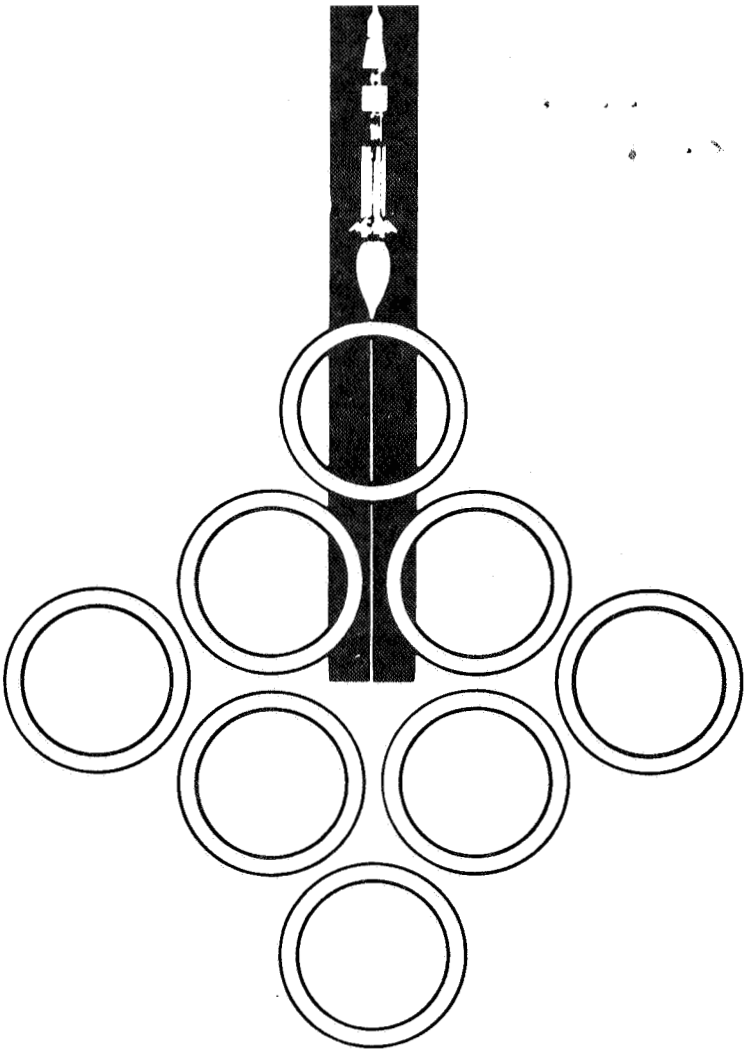


ENGINEERING DEPARTMENT

TECHNICAL REPORT

TR-RE-CCSD-FO-1125-3

April 15, 1967

SATURN IB PROGRAM

TEST REPORT
FOR

ANGLE VALVE, 3/4-Inch

Annin Company Model Number 3611

NASA Part Number 10428552

SPACE DIVISION CHRYSLER CORPORATION

TEST REPORT

FOR

ANGLE VALVE, 3/4-INCH

Annin Company Model Number 3611

NASA Drawing Number 10428552

ABSTRACT

This report presents the results of tests performed on one specimen of the Angle Valve 10428552. The following tests were performed:

1. Receiving Inspection
2. Proof Pressure
3. Functional
4. Flow
5. Surge
6. Low Temperature
7. High Temperature
8. Cycle
9. Burst

The specimen's performance was in accordance with the specification requirements of NASA drawing number 10428552, except during burst testing.

During burst testing, the valve failed at 21,000 psig. The specification requirements were that the valve withstand a minimum burst pressure of 24,000 psig.

TR-RE-CCSD-FO-1125-3

TEST REPORT

FOR

ANGLE VALVE, 3/4-INCH

Annin Company Model Number 3611

NASA Drawing Number 10428552

April 15, 1967

CHRYSLER CORPORATION SPACE DIVISION - NEW ORLEANS, LOUISIANA

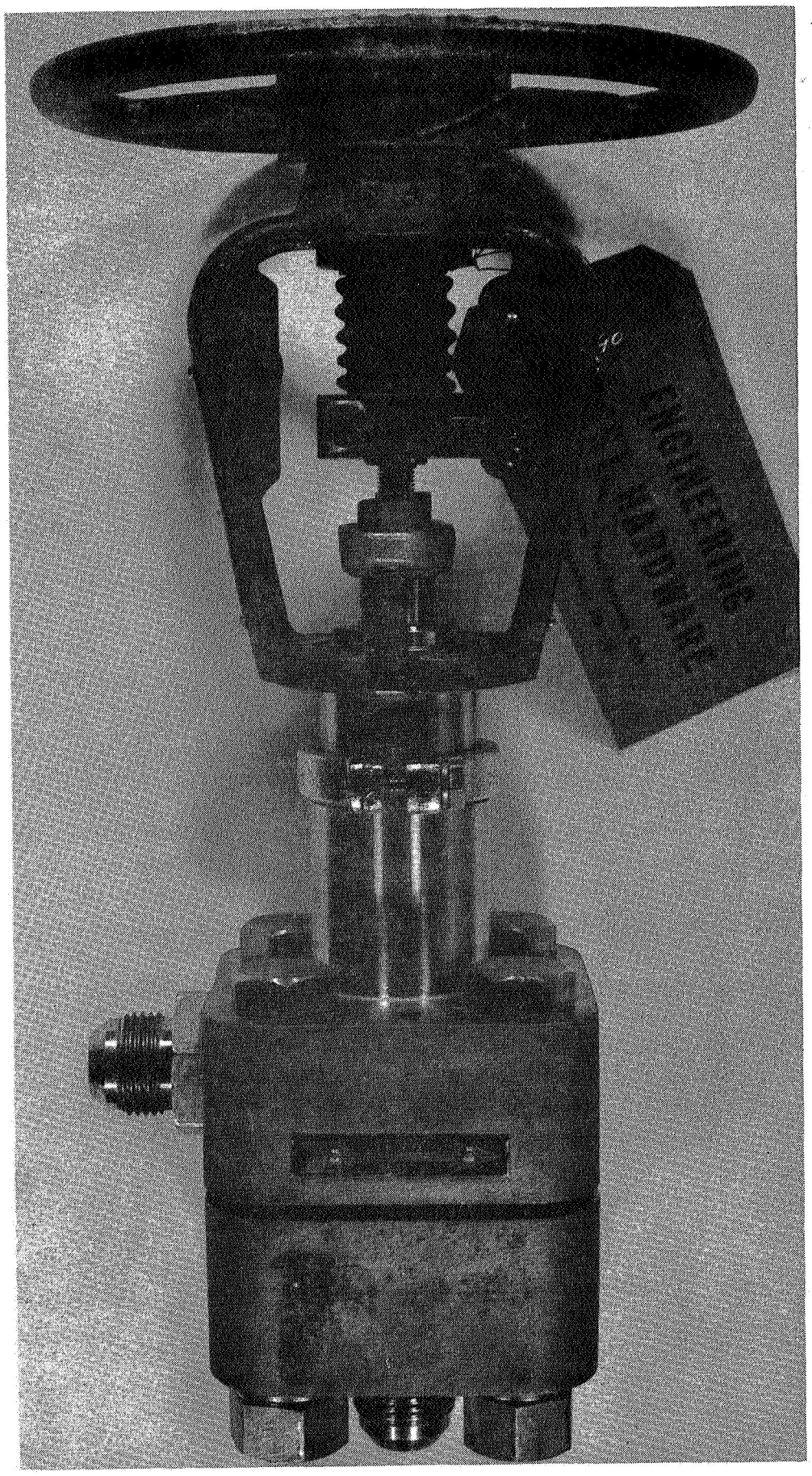
FOREWORD

The tests reported herein were conducted for the John F. Kennedy Space Center by Chrysler Corporation Space Division (CCSD), New Orleans, Louisiana. This document was prepared by CCSD under Contract NAS 8-4016, Part VII, CWO 271620.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES



Angle Valve 10428552

CHECK SHEET

FOR

ANGLE VALVE, 3/4-INCH

MANUFACTURER: Annin Company
MANUFACTURER'S MODEL NUMBER: 3611
NASA DRAWING NUMBER: 10428552
TESTING AGENCY: Chrysler Corporation Space Division, New Orleans, Louisiana
AUTHORIZING AGENCY: NASA KSC

I. FUNCTIONAL REQUIREMENTS

A.	OPERATING MEDIUM:	He or GN_2
B.	OPERATING PRESSURE:	6000 psig
C.	PROOF PRESSURE:	9000 psig
D.	BURST PRESSURE:	24,000 psig
E.	VALVE CAPACITY:	(C_v) 9.1 (min)
F.	LEAKAGE:	Bubble tight below 6000 psig
G.	TORQUE:	
1.	Valve stem maximum-	Determined by test
2.	Breakaway -	60 ft-lb typical
3.	Running -	25 ft-lb typical
4.	Seating -	30 ft-lb typical

II. CONSTRUCTION

A.	BODY MATERIAL:	316 stainless steel, passivated per 5.4.1 of MIL-STD-171
B.	SEAT MATERIAL:	Teflon
C.	OUTLET PORT:	AND10050-12
D.	INLET PORT:	3/4-inch AND10050-12
E.	SECTIONAL DIMENSIONS:	Drawing 10428552

III. ENVIRONMENTAL REQUIREMENTS

A.	OPERATING TEMPERATURE:	-20 to +120°F

IV. LOCATION AND USE: The angle valve is located in the Saturn IB ground support equipment of Launch Complex 34. The valve is used in the pneumatic system to shut off GN_2 of H_e.

TEST SUMMARY

ANGLE VALVE, 3/4-INCH
10428552

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Receiving Inspection	1	NASA Drawing No. 10428552	Visual and dimensional examination for compliance	Satisfactory	No visual deviations from the specification or good workmanship
Proof Pressure	1	9,000 psig for five-minutes	Check for leakage or distortion	Satisfactory	No leakage or distortion
Functional Test	1	Leakage: Bubble tight at 6000	Check for leakage and establish opening and closing and running torque values	Satisfactory	No leakage Torque values: Opening- 50 ft-lb Running- 20 ft-lb Closing- 25 ft-lb
Flow Test	1	Desired C_v is 9.1	Determine C_v for the valve	Satisfactory	Maximum C_v of 6.0 was found between 11 gpm and 20 gpm. Cause: Restriction in the end fittings
Surge Test	1	0 to 6000 psig in 100-milliseconds. 10 cycles with valve partially open	Determine if specimens operation is impaired by surge	Satisfactory	No leakage or apparent distortion due to surge
Low Temperature Test	1	-20°F (+0,-4°F)	Determine if the environments cause degradtion or deformation	Satisfactory	No leakage or apparent distortion due to thermal change
High Temperature Test	1	+160°F(+4,-0°F)			
Cycle Test	1	Operating the specimen for 1000 complete cycles with 6000 psig on inlet to valve.	Determine if the environment causes degradation or distortion due to accumulative wear	Satisfactory	No leakage or apparent distortion due to cycling

TEST SUMMARY

ANGLE VALVE, 3/4-INCH

10428552

Environment	Units	Operational Boundary	Test Objective	Test Results	Remarks
Burst Pressure Test	1	Minimum of 24,000 psig for 5-minutes	Determine the structural integrity of the specimen	Unsatisfactory	The valve stem packing gland failed at 21,000 psig

SECTION I

INTRODUCTION

1.1 SCOPE

1.1.1 This report describes the testing of 3/4-inch Angle Valve 10428552. Tests included were those necessary to determine whether the valve will satisfy the operational and environmental requirements of the John F. Kennedy Space Center.

1.1.2 One specimen was tested.

1.2 ITEM DESCRIPTION

Angle Valve 10428552 has a 3/4-inch nominal size inlet port. It has a design operating pressure of 6000 psig and is rated for use with nitrogen or helium.

1.3 APPLICABLE DOCUMENTS

The following documents contain the test requirements for Angle Valve 10428552:

a. KSC-STD-164(D), Standard Environmental Test Methods for Ground Support Equipment Installations at Cape Kennedy.

b. Component Specification, 10428552

c. Cleanliness Standard, MSFC-STD-164(D)

d. Test Plan, TP-RE-CCSD-FO-1125-1F

SECTION II

RECEIVING INSPECTION

2.1 TEST REQUIREMENTS

The specimen shall be visually and dimensionally inspected for conformance with the applicable specifications prior to the start of the tests.

2.2 TEST PROCEDURE

A visual and dimensional inspection was performed to determine compliance with NASA drawing 10428552 and applicable vendor drawings to the extent possible without disassembling the test specimen. At the same time the test specimen was also inspected for poor workmanship and manufacturing defects.

2.3 TEST RESULTS

The specimen complied with NASA drawing 10428552. No evidence of poor workmanship was observed.

2.4 TEST DATA

The data presented in table 2-1 were recorded during the inspection.

Table 2-1. Specimen Specifics

Name:	Annin, 3/4-inch, Angle Valve
Size:	3/4-inch
Part Number:	3611
Serial Number	62280-1-1
Height, Overall (inches)	12.50
Width, Main Body(inches)	3.75
Operating Wheel Diameter (inches)	6.90

SECTION III

PROOF PRESSURE TEST

3.1 TEST REQUIREMENTS

3.1.1 The test specimen shall be subjected to a proof pressure of 9000 psig.

3.1.2 The pressure shall be applied simultaneously to the inlet and outlet ports, with the specimen in the open position, and shall be maintained for 5 minutes.

3.1.3 The test specimen shall be inspected for leakage and distortion.

3.2 TEST PROCEDURE

3.2.1 The specimen was installed in the test setup as shown in figure 3-1 and 3-3 using the equipment listed in table 3-1.

3.2.2 Regulator 15 was adjusted for zero outlet pressure.

3.2.3 The specimen and hand valves 5, 6, 8, 9, 10, 11 and 24 were opened and the system was filled with de-ionized water. All air was bled from the system.

3.2.4 Hand valves 5, 8, 9, 11 and 24 were closed.

3.2.5 Hand valve 7 was opened, and 3000 psig GN_2 was monitored on gage 14.

3.2.6 Regulator 21 was adjusted until a pressure of between 50 and 100 psig was indicated on gage 15.

3.2.7 Switch 17 was then closed. Solenoid valve 18 was opened and pump 19 started.

3.2.8 The pump continued to operate until a pressure of 9000 psig was indicated on gage 3. Switch 17 was then opened to stop pumping.

3.2.9 The 9000 psig pressure was maintained for 5 minutes, and the specimen was checked for leakage.

3.2.10 Hand valves 9, 11 and 24 were opened and the system was vented. The specimen was then checked for distortion.

3.2.11 All data were recorded.

3.3 TEST RESULTS

3.3.1 The specimen did not leak and there was no evidence of distortion.

3.4 TEST DATA

Test data presented in table 3-2 were recorded during the test.

Table 3-1. Proof Pressure and Burst Test Equipment List

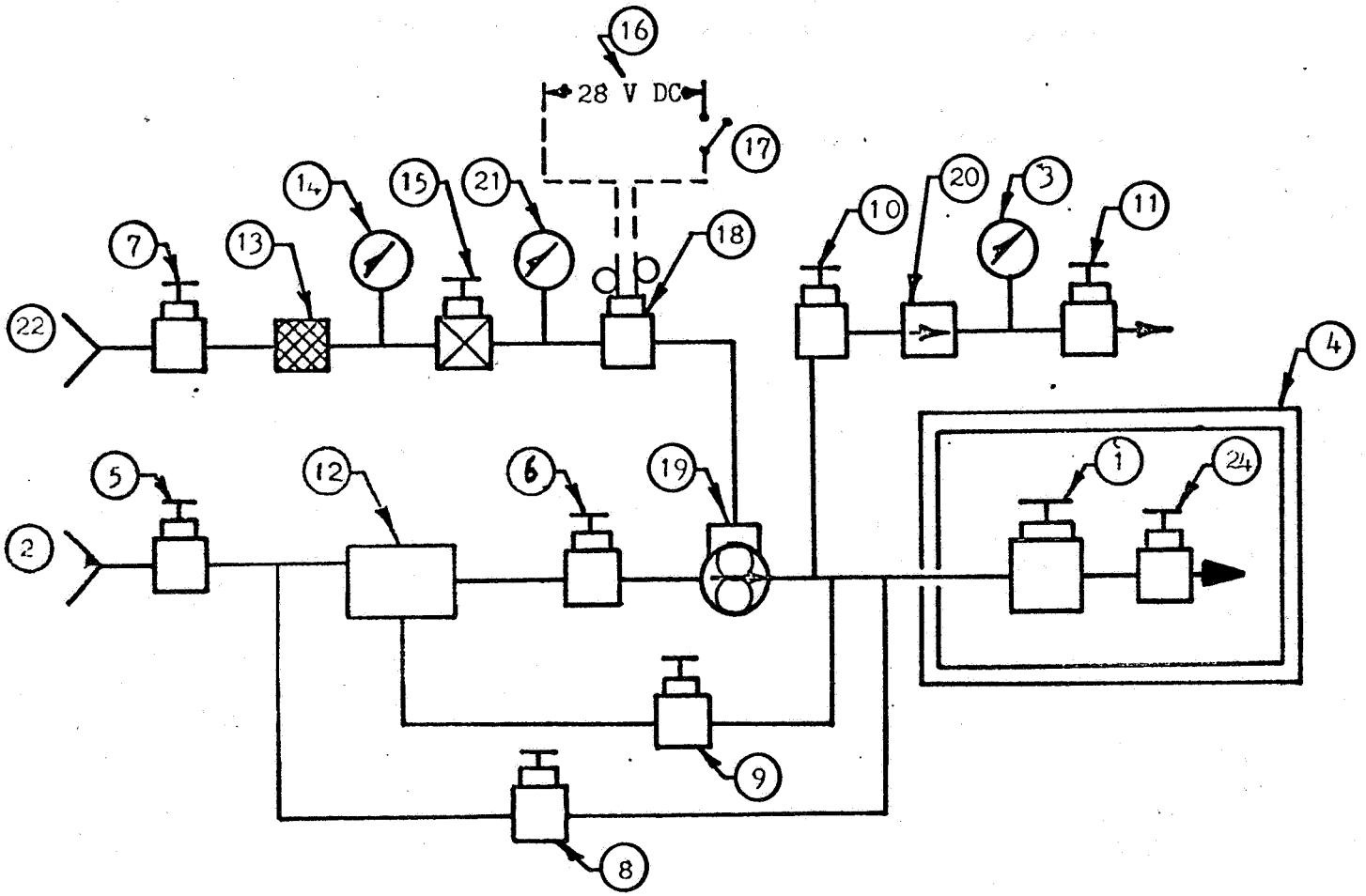
Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Annin Company	3611	NA	3/4-inch Angle Valve
2	Water Supply	NOPSI	NA	NA	Tap water
3	Pressure Gage	Ashcroft	NA	BT-1396-B	0-to 20,000-psig ±1.0% FS Cal date 10-1-66 4-1-67
3A	Pressure Gage (Burst Test)	Astra	NA	011893-A	0-to 100,000-psig ± 2.0% FS Cal date 11-2-66 4-30-67
4	Burst Chamber	CCSD	NA	201344	3 ft. by 3 ft. by 3 ft.
5	Hand Valve	Aminco	50011A	NA	1/4-inch
6	Hand Valve	Aminco	50011A	NA	1/4-inch
7	Hand Valve	Aminco	50011A	NA	1/4-inch
8	Hand Valve	Aminco	50011A	NA	1/4-inch
9	Hand Valve	Aminco	50011A	NA	1/4-inch
10	Hand Valve	Aminco	50011A	NA	1/4-inch
11	Hand Valve	Aminco	50011A	NA	1/4-inch
12	Water Reservoir	CCSD	NA	NA	2-gallon
13	Pneumatic Filter	Bendix Corp.	1731260	NA	2-micron
14	Pressure Gage	Ashcroft	10575	NA	0-to 5000-psig ±2% FS
15	Pressure Gage	USG	8990	NA	0-to 300-psig ±2% FS
16	Power Supply	CCSD	NA	NA	28-vdc
17	Switch	Cutler Hammer	NA	NA	SPST

Table 3-1. Proof Pressure and Burst Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
18	Solenoid Valve	Marotta Valve Co.	207803	NA	2-way, normally closed
19	Hydrostatic Pump	Sprague Engr. Corporation			Air operated; maximum pressure 50,000-psig
20	Check Valve	Aminco	44-6305	NA	1/4-inch
21	Regulator	Marotta Valve Co.	NA	NA	3000-psig inlet; 0-to 200-psig outlet
22	GN_2 Pressure Source	Air Products	NA	NA	3000-psig
23	Hand Valve	Aminco	50011A	NA	1/4-inch

Table 3-2. Proof Pressure Test Data

Pressure	9,000 psig 5 minutes
Leakage	Zero
Distortion	None



Note: All lines ¼-inch.
Refer to table 3-1 for item identification.

Figure 3-1. Proof Pressure And Burst Test Schematic

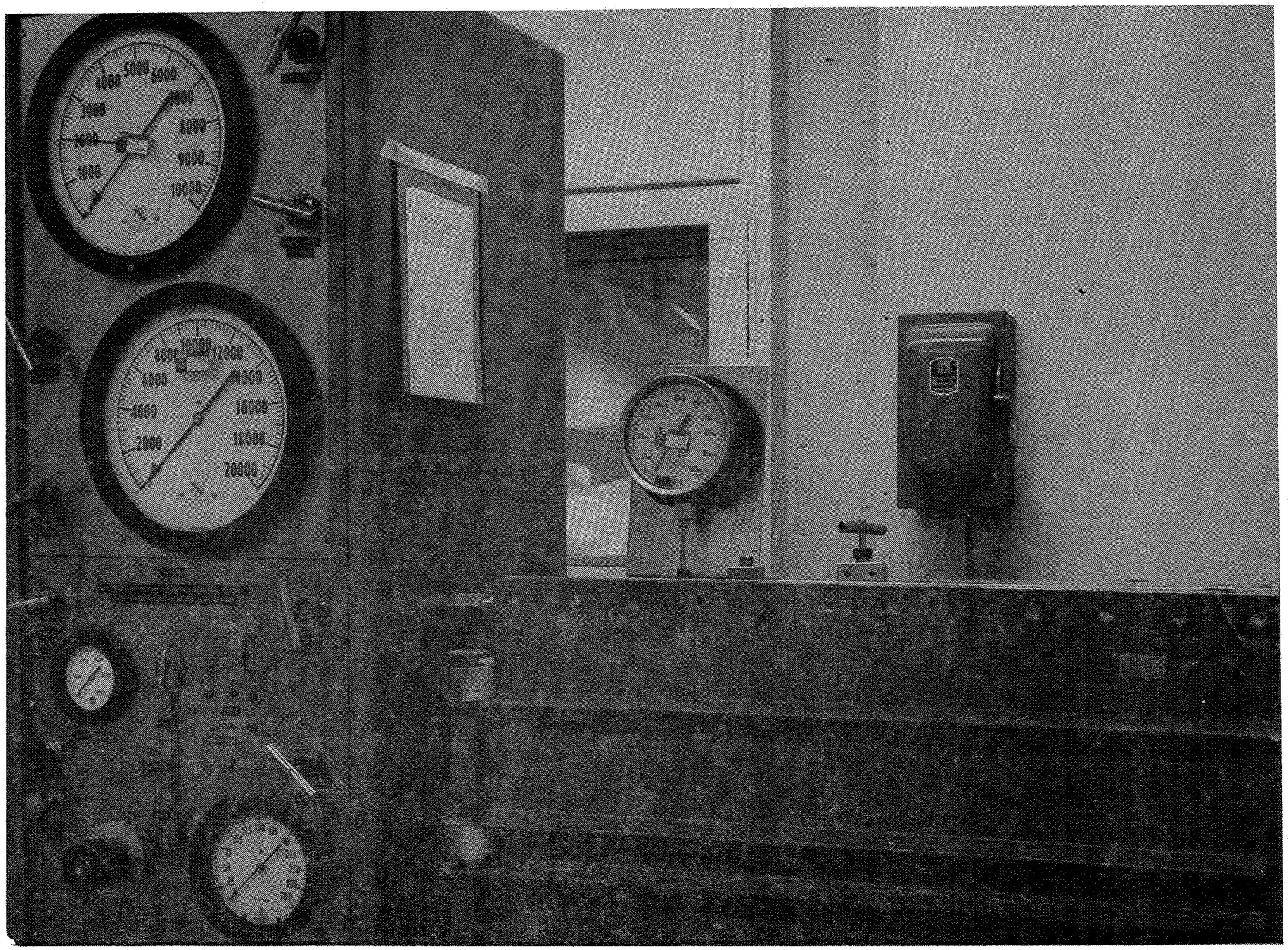


Figure 3-2. Proof Pressure And Burst Test Console

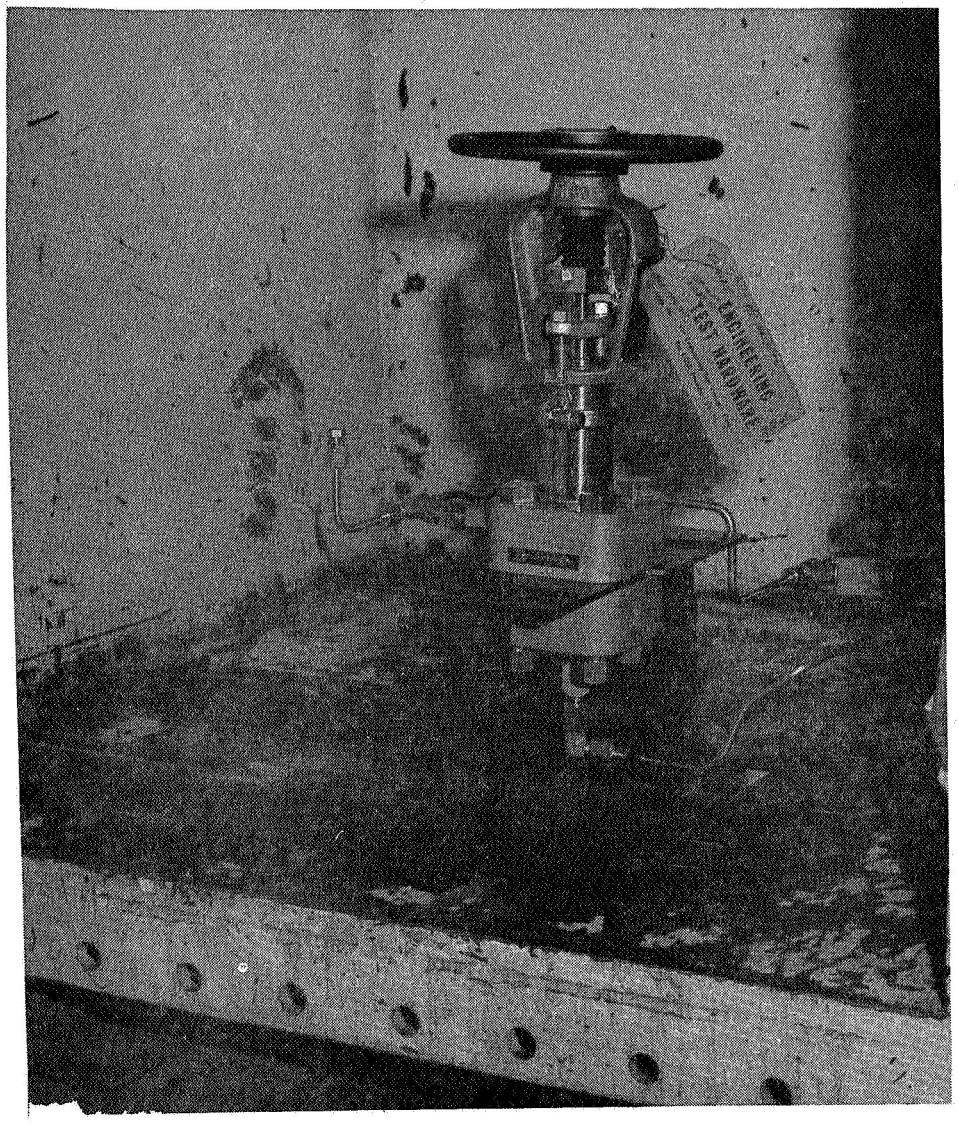


Figure 3-3. Proof Pressure And Burst Test Setup

SECTION IV

FUNCTIONAL TEST

4.1 TEST REQUIREMENTS

4.1.1 The test specimen shall be inspected for leakage with the outlet port of the specimen pressurized to 6000 psig, specimen closed, and the inlet port vented. Leakage shall be recorded.

4.1.2 The test specimen shall be inspected for leakage with the inlet port of the specimen pressurized to 6000 psig, specimen closed, and the outlet port vented. Leakage shall be recorded.

4.1.3 The opening, closing, and normal running torque of the specimen shall be determined with the inlet port pressurized to 6000 psig and then relieved to zero psig. Record all data.

4.1.4 Procedures 4.1.1 and 4.1.2 each, shall be repeated once for the initial functional test and performed once for all subsequent functionals. Procedure 4.1.3 shall be performed 10 times initially and 3 times for all subsequent functionals.

4.2 TEST PROCEDURE

4.2.1 The specimen was installed in the test setup as shown in figure 4-1 and 4-2 using the equipment listed in table 4-1 except for thermocouple 18 and thermal chamber 19. All hand valves were closed.

4.2.2 The hand wheel was removed and replaced with valve stem adapter 21 and torque wrench 22. The specimen was closed using 180 inch-pounds.

4.2.3 All regulators were adjusted for zero outlet pressure.

4.2.4 Hand valves 3 and 8 were opened, and gage 5 indicated 7000 psig.

4.2.5 Pressure regulator 7 was adjusted until gage 9 indicated 6000 psig.

4.2.6 Port C on leakage detector 20 was connected to port A of hand valve 16.

4.2.7 Hand valves 12 and 16 were opened. There were no bubbles in leakage detector 20.

4.2.8 Regulator 7 was adjusted for zero outlet pressure, and hand valve 17 was opened and the specimen was vented.

4.2.9 Hand valves 16 and 17 were closed and port C of leakage detector 20 was connected to port B of hand valve 17.

4.2.10 Procedures 4.2.5 through 4.2.8 were repeated.

4.2.11 Regulator 7 was slowly adjusted and 6000 psig pressure was applied to the inlet port of the valve.

4.2.12 The breakaway torque of the specimen was measured and recorded by slowly applying the maximum torque required to unseat the specimen.

4.2.13 The specimen was then fully opened. The running torque was then measured between breakaway and open.

4.2.14 The specimen was then closed, and the running torque during closing was measured.

4.2.15 Hand valve 17 was then opened and the outlet port of the specimen was vented. Leakage detector 20 was connected to port B of valve 17.

4.2.16 With the pressure on the inlet port of the specimen, the specimen was slowly opened until bubbles appeared in leakage detector 20.

4.2.17 The specimen was slowly closed and the torque measured. This was the closing torque for the specimen at operating pressure.

4.2.18 Regulator 7 was closed and hand valve 16 was opened to vent the specimen.

4.2.19 The procedures described in 4.2.12 through 4.2.14 were repeated to determine breakaway and running torque values for the unpressurized specimen.

4.2.20 Hand valves 11, 12, 16 and 17 were closed. Hand valves 10 and 15 were opened, and regulator 13 was adjusted until 2 psig was indicated on gage 14.

4.2.21 Hand valve 17 was opened.

4.2.22 The specimen was opened until bubbles appeared in leakage detector 20.

4.2.23 The specimen was slowly closed and the torque required to stop the bubbles was recorded as the reseating torque for unpressurized conditions of the specimen.

4.2.24 Regulators 7 and 13 were adjusted to zero outlet pressure, hand valve 16 was opened, and the inlet port of the valve was vented.

4.2.25 With the specimen unpressurized, the valve was closed using 100 inch-pounds of torque. Procedures 4.2.11 through 4.2.24 were repeated 10 times and the data were recorded in table 4-2.

4.3 TEST RESULTS

No malfunction or degradation occurred.

4.4 TEST DATA

The test data are presented in table 4-2.

Table 4-1. Functional Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen				
2	Helium and Nitrogen Source	CCSD	NA	NA	7000-psig
3	Hand Valve	Combination Pump and Valve Co.	380-3	NA	1 1/2-inch supply
4	Filter	Microporous	4813F-2M	NA	2-micron
5	Pressure Gage	Duragage	NA	NASA	0-to 10,000 psig ±2% FS Cal date 1-25-67 4-24-67
6	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
7	Regulator	Tescom Corp.	26-1002	1002	7000-psig inlet 0-to 7000-psig outlet
8	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
9	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
10	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
11	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
12	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
13	Regulator	Tescom Corp.	26-1002	1009	100-psig inlet 0-to 10-psig outlet
14	Pressure Gage	Marsh Inst. Co.	NA	NASA-08-113-1142B	0-to 30-psig ±0.5% FS Cal date 1-10-67 4-10-67

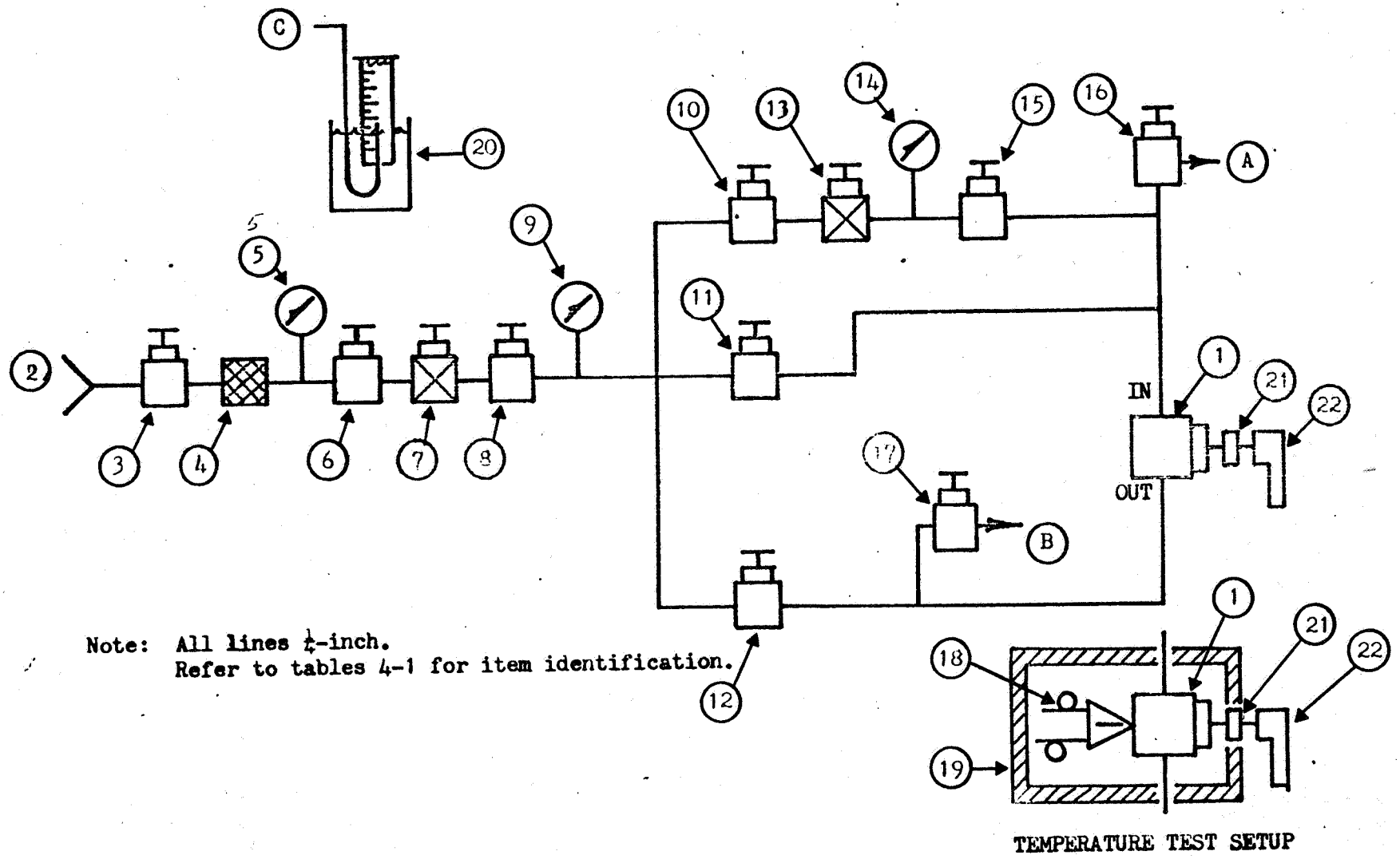
Table 4-1. Functional Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
15	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
16	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
17	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
18	Thermocouple	Honeywell Corp.	30112	NA	-50 to +200°F ±2.5°F (temperature test only)
19	Thermal Chamber	Conard Corp.	NA	NASA-08-113-2049-41	-25 to +165°F (temperature test only)
20	Leakage Detector	Pyrex Co.	NA	NA	400 ml. capacity graduated cylinder and beaker
21	Valve Stem Adapter	CCSD	NA	NA	Replace hand wheel of specimen (when required)
22	Torque Wrench	Armstrong	SR-100	NASA	

Table 4-2. Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft/lb)		Closing Torque (ft-lb)
				Opening	Closing	
	180	6000	50	15	20	25
1	180	0	20	20	15	-
	180	2	15	-	-	5
	100	6000	55	20	20	25
2	100	0	25	15	10	-
	100	2	10	-	-	5
	100	6000	50	15	20	15
3	100	0	20	10	10	-
	100	2	10	-	-	5
	100	6000	50	15	20	15
4	100	0	15	10	10	-
	100	2	13	-	-	4
	100	6000	50	15	20	15
5	100	0	15	8	5	-
	100	2	10	-	-	3
	100	6000	45	15	17	13
6	100	0	17	5	3	-
	100	2	10	-	-	3
	100	6000	45	15	20	15
7	100	0	15	5	4	-
	100	2	7	-	-	3
	100	6000	45	15	17	13
8	100	0	15	4	3	-
	100	2	4	-	-	3
	100	6000	45	15	17	13
9	100	0	13	4	3	-
	100	2	4	-	-	3
	100	6000	45	14	17	13
10	100	0	13	4	3	-
	100	2	4	-	-	2

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0



Note: All lines ¼-inch.
Refer to tables 4-1 for item identification.

Figure 4-1. Functional Test Schematic

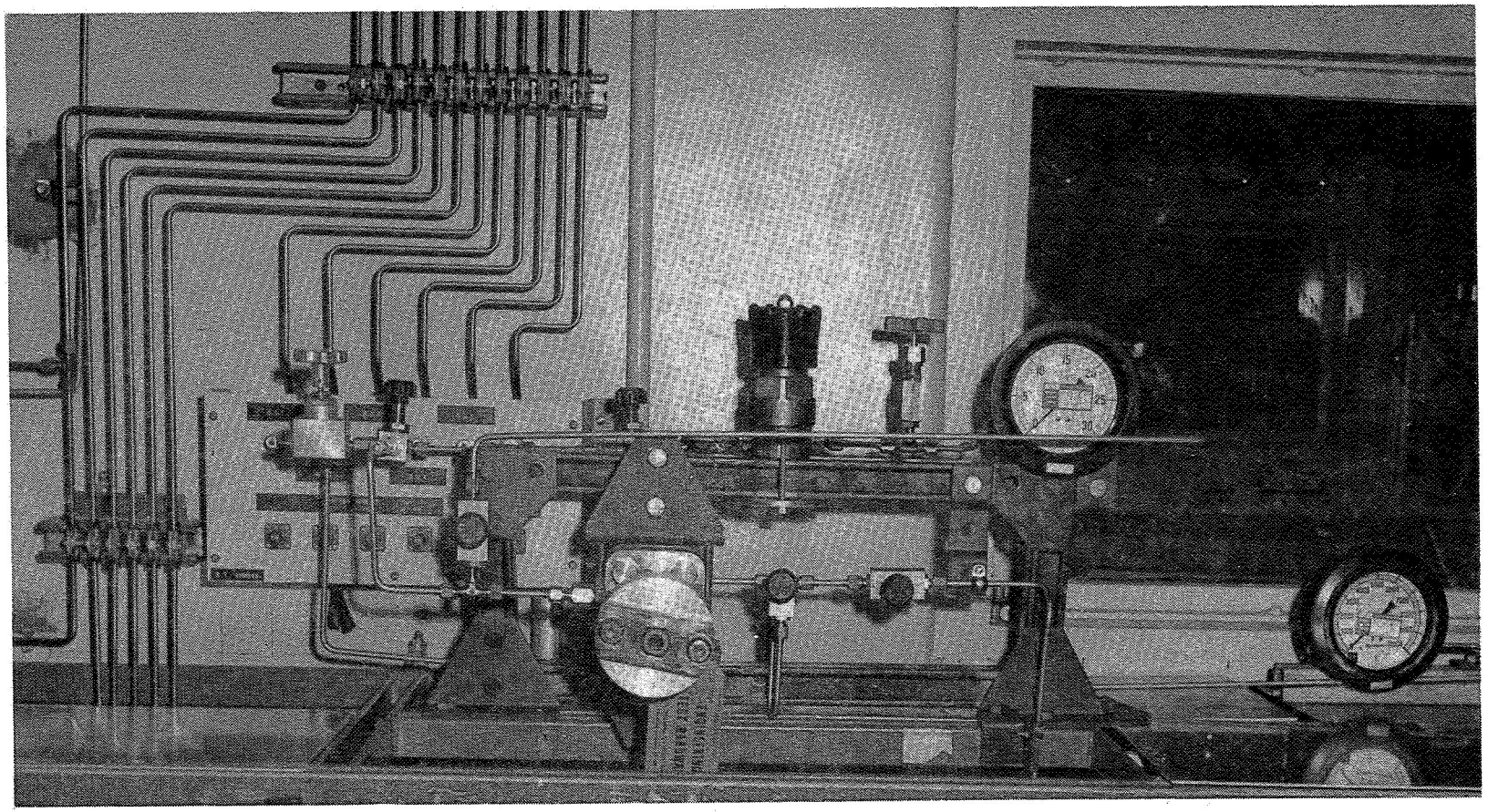


Figure 4-2. Functional Test Setup

SECTION V

FLOW TEST

5.1 TEST REQUIREMENTS

5.1.1 The valve capacity (C_V) of the specimen shall be determined. The minimum C_V shall be 9.1.

5.2 TEST PROCEDURE

5.2.1 The specimen was installed in the test setup as shown in figure 5-1 and 5-3 using the equipment listed in table 5-1. All hand valves and regulators were closed.

5.2.2 The specimen was opened.

5.2.3 Hand valve 3 was opened and gage 4 indicated 100 psig.

5.2.4 Regulator 5 was used to regulate flow rate to the specimen over the full range of testing.

5.2.5 Ten readings were recorded in gallons per minute. Specimen inlet pressure and pressure drop, indicated by gages 9, 10 and 11 and the water temperature indicated by thermocouple 8, were recorded.

5.3 TEST RESULTS

5.3.1 **The flow coefficient (C_V) of the specimen was 6.0 (average)** when calculated over a flow range between 10 and 25 gallons per minute and was below the 9.1 desired.

5.3.2 Analysis of the problem revealed that to meet the specified flow coefficient an equivalent orifice diameter of 0.710 inches was required. However, the specification also requires the valve to be equipped with AND10050-12 end connections which have an internal diameter of 0.609 inches. The limited C_V of 6.0 obtained during test was therefore a function of the end connection rather than the valve configuration.

5.4 TEST DATA

5.4.1 The test data recorded during the test are presented in table 5-2. Pressure drop versus flow rate is presented in figure 5-3.

5.4.2 The flow coefficient (C_V) was computed using the following formula:

$$C_V = Q \sqrt{\frac{\rho_T}{\rho \Delta P}}$$

where: Q = measured flow rate (gpm)

ΔP = pressure drop across the specimen (psid)

ρ_T = density of the water at the temperature indicated by the temperature probe

ρ = density of the water at 60°F

5.4.3 Data from the pre-flow functional test are presented in table 5-3.

Table 5-1. Flow Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Annin Company	3611	NA	3/4-inch angle valve
2	Water Supply	NA	NA	NA	Tap water
3	Hand Valve	Williams Co.	200 SP	NA	2-inch
4	Pressure Gage	Heise	NA	NASA 08-113-93-1092-C	0-to 1000-psig ±0.2% FS Cal date 9-21-66 12-30-66 3-21-67
5	Pressure Regulator	Denison Div. American Brake Shoe Co.	FCC122 3106	NA	1-inch
6	Pressure Gage	Ashcroft	NA	NASA 08-113-95-1209-B	0-to 1000-psig ±1.0% FS Cal date 10-30-66 1-30-67 4-30-67
7	Turbine Flowmeter	Cox Instrument Division	16-SCRX	3498	0-to 50-gpm Cal date 9-18-66 12-16-66 3-13-67
8	Thermocouple	West Inst. Corp.	30112	NA	-50 to +200°F ±2.5°F Cal date 10-3-66 2-31-67
9	Pressure Gage	Heise	NA	NASA 08-113-14227	0-to 100-psig ±0.2% FS Cal date 11-18-66 2-15-67

Table 5-1. Flow Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
10	Pressure Gage	Heise	NA	NASA 08-113-14228	0-to 100-psig ± 0.2% FS Cal date 11-18-66 2-15-67
11	Pressure Gage	Heise	NA	NASA 08-113-12450	0-to 100-psig ±0.2% FS Cal date 12-1-66 3-7-67
12	Hand Valve	Williams Co.	200 SP	NA	2-inch

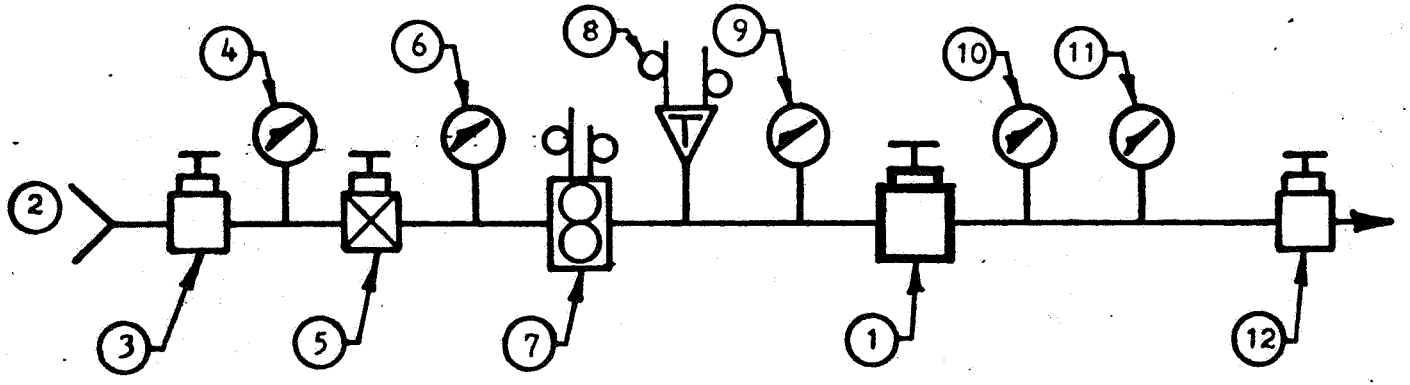
Table 5-2. Flow Test Data

Flow (gpm)	Specimen Pressure		Tare (psi)	ΔP (psi)	Media Temperature (°F)
	Upstream (psig)	Downstream (psig)			
3	1.3	0.8	0.0	0.5	50
5	2.6	1.4	0.0	1.2	50
8	5.1	2.7	0.1	2.3	50
10	7.2	3.9	0.2	3.1	50
12	9.8	5.3	0.4	4.1	50
15	14.4	7.4	0.7	6.3	50
17	17.7	8.8	1.0	7.9	50
20	22.8	10.5	1.1	11.2	50
23	28.9	12.8	1.4	14.7	50
25	33.0	14.1	1.8	17.1	50
20	22.2	10.0	1.2	11.0	50
17	16.5	7.5	1.0	8.0	50
15	12.9	6.0	0.8	6.1	50
12	8.6	4.1	0.4	4.1	50
10	6.4	3.0	0.3	3.1	50
8	4.0	1.9	0.2	1.9	50
5	1.8	1.0	0.2	0.6	50
3	0.7	0.3	0.1	0.3	50

Table 5-3. Pre-Flow Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	45	14	17	20
	100	0	13	4	4	-
	100	2	5	-	-	3
2	100	6000	50	15	18	20
	100	0	15	4	3	-
	100	2	4	-	-	2
3	100	6000	45	15	20	20
	100	0	13	4	3	-
	100	2	4	-	-	2

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0



Note: All lines 3/4-inch.
Refer to table 5-1 for item identification.

Figure 5-1. Flow Test Schematic

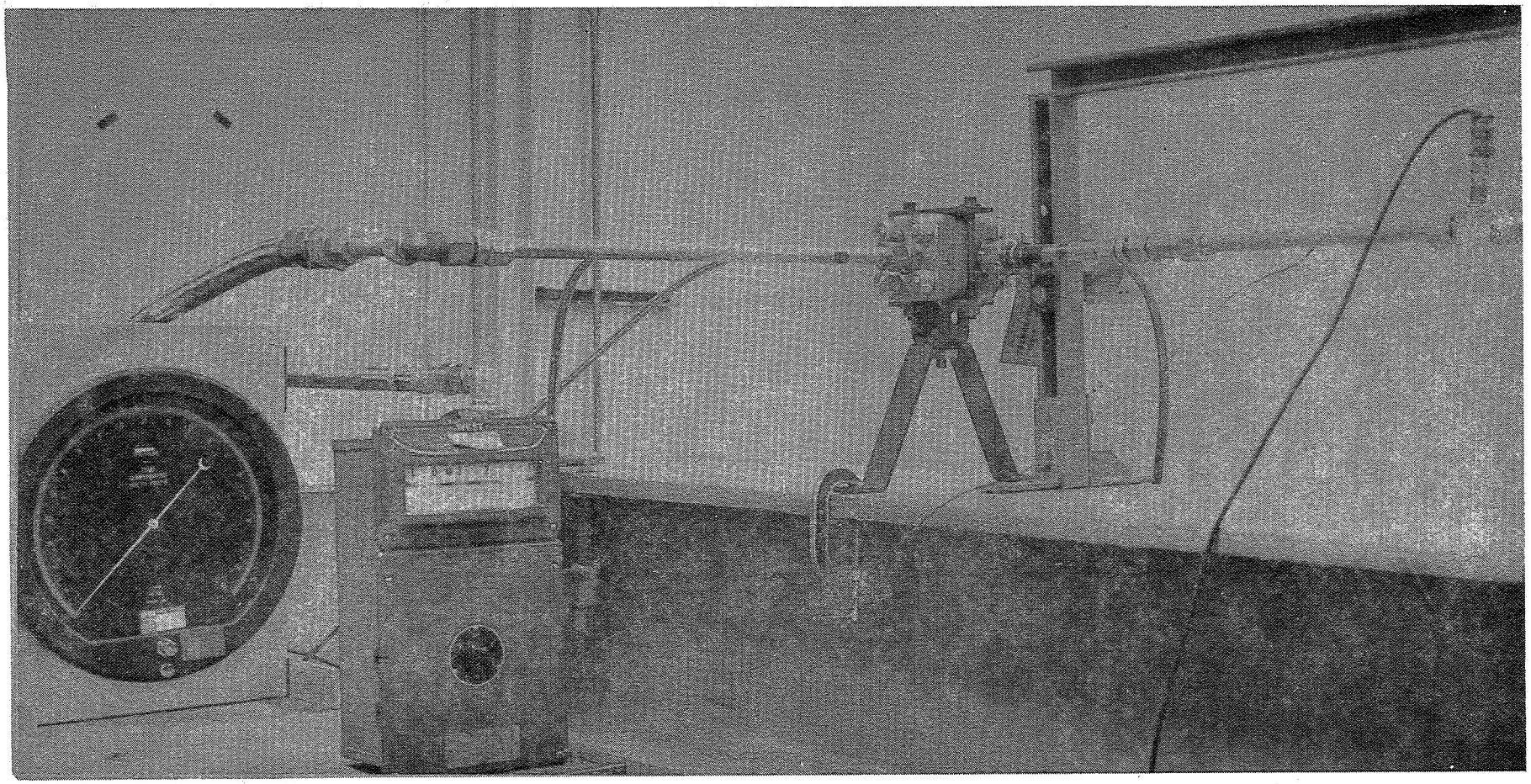


Figure 5-2. Flow Test Setup

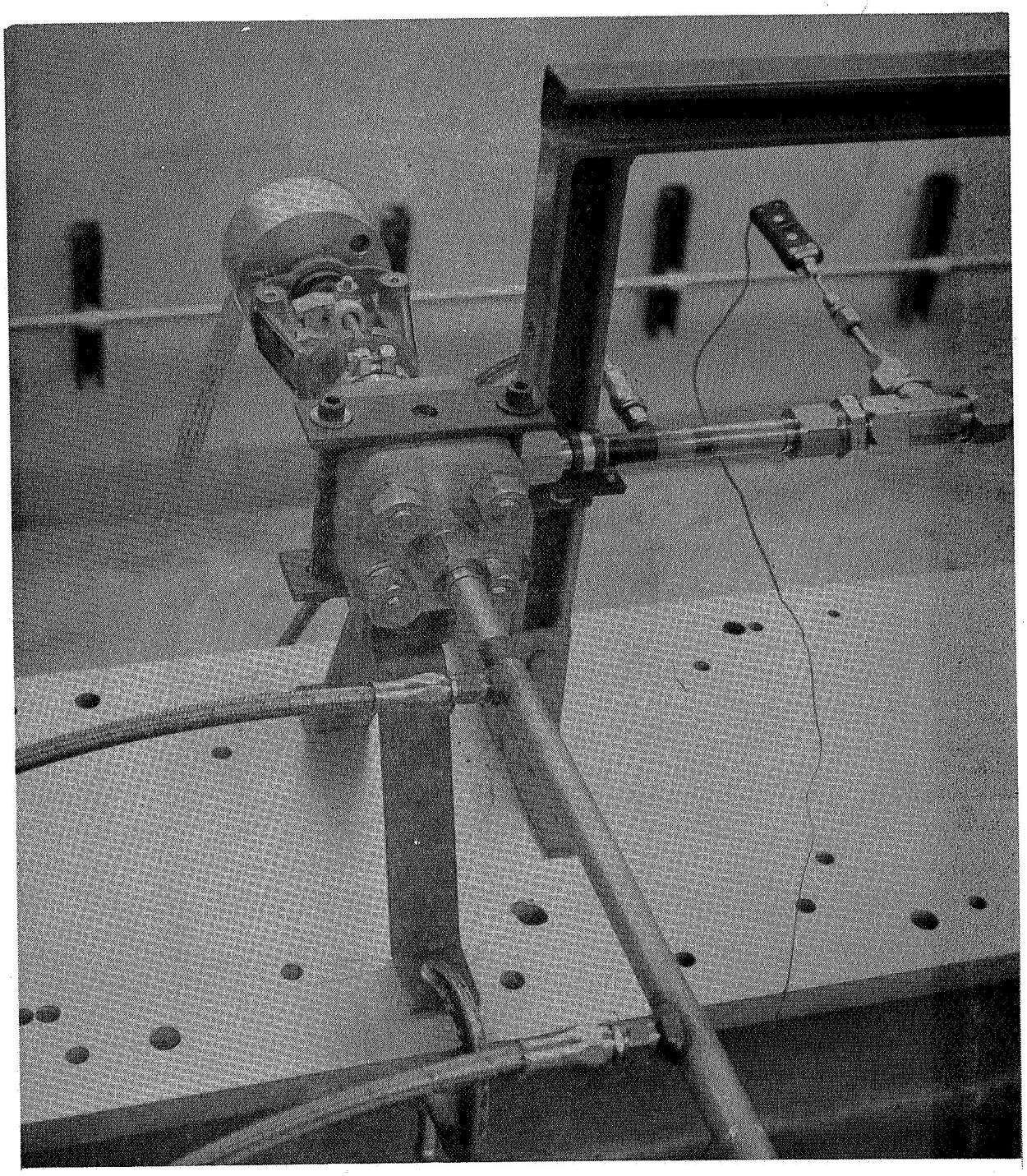


Figure 5-3. Flow Test Close-up

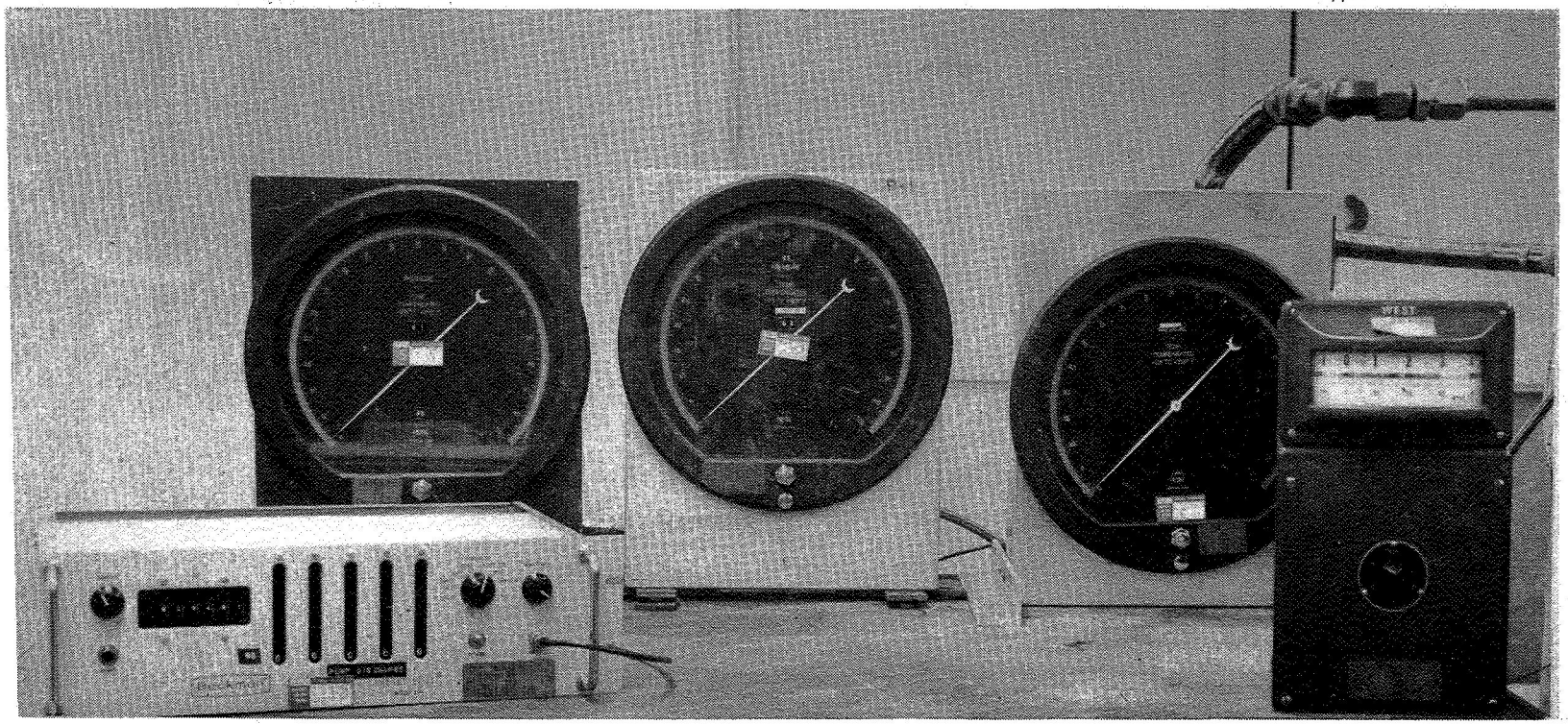


Figure 5-4. Flow Test Instrumentation

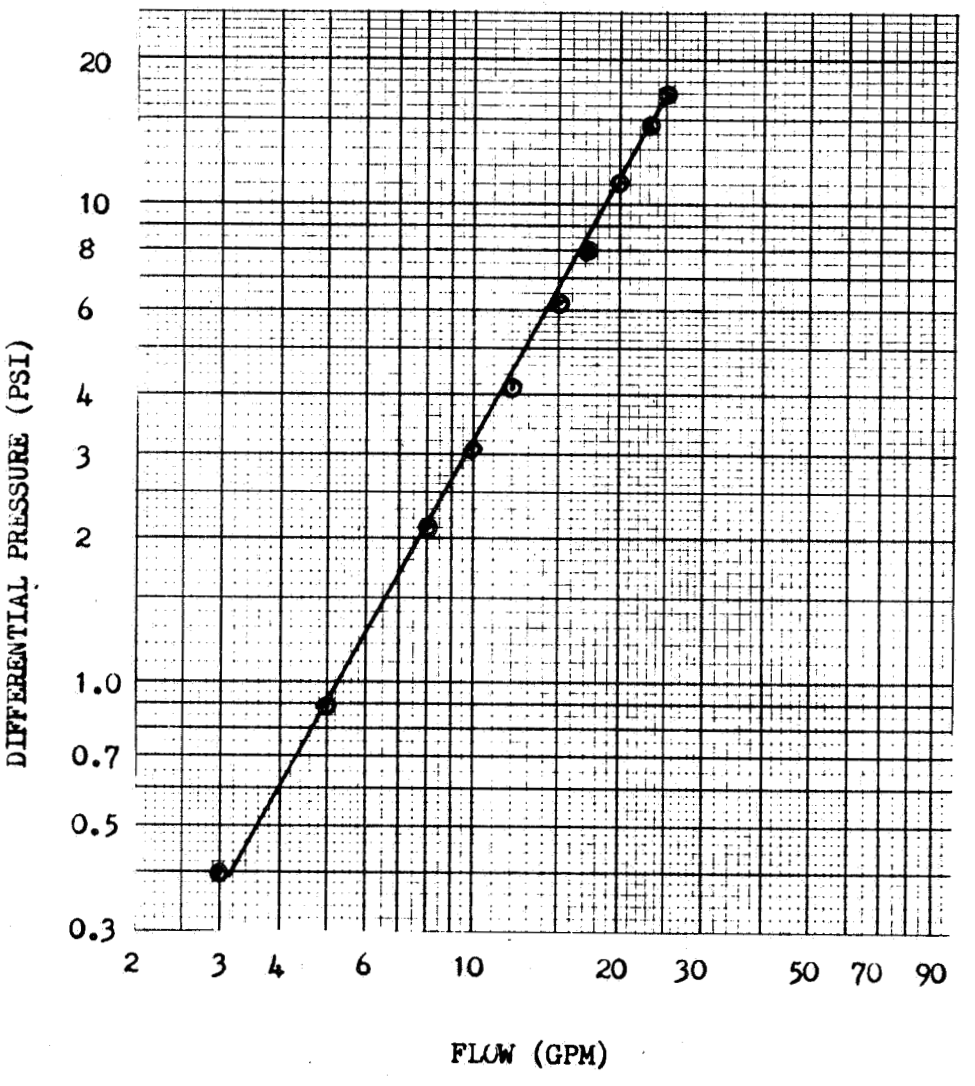


Figure 5-5. Pressure Versus Flow Rate

SECTION VI

SURGE TEST

6.1 TEST REQUIREMENTS

6.1.1 The test specimen shall be subjected to 20 pressure surges, 10 with the specimen closed and 10 with the specimen partially opened.

6.1.2 Each pressure surge shall be a pressure increase from zero to 6000 psig within 100 milliseconds.

6.1.3 The downstream side of the specimen shall be vented after each surge, when the specimen is partially opened.

6.2 TEST PROCEDURE

6.2.1 The specimen was installed in the test setup as shown in figure 6-1 and 6-2 using the equipment listed in table 6-1. All hand valves, regulators and the specimen were closed for zero pressure.

6.2.2 Hand valve 2 was opened.

6.2.3 Pressure gage 4 indicated the supply pressure of 7000 psig.

6.2.4 Regulator 5 was adjusted until gage 6 indicated 6000 psigs.

6.2.5 Switch 18 was closed and solenoid valve 8 actuated and 6000 psig was applied to the inlet port of the specimen.

6.2.6 The output from pressure transducer 15 and the time for each run were recorded on oscillograph 16.

6.2.7 Switch 18 was opened to deactuate solenoid valve 8.

6.2.8 Procedures 6.2.5 through 6.2.7 were repeated 10 times.

6.2.9 The specimen was partially opened (cracked), and the vent port of solenoid valve 8 was capped.

6.2.10 Procedures 6.2.5 through 6.2.7 were repeated for 10 additional cycles, opening hand valve 12 after each cycle and venting downstream pressure from the specimen.

6.2.11 The specimen was examined for distortion after each cycle, and functionally tested prior to and after surge testing. The data are recorded in tables 6-2 and 6-3.

6.3 TEST RESULTS

6.3.1 The specimen was cycled 10 times in the closed position with a pressure of zero to 6000 psig and a rise rate of 60 milliseconds. The second 10 cycles were performed with the specimen in the partially opened position (cracked), with a zero to 6000 psig pressure and a rise rate of 80-milliseconds. The specimen demonstrated no adverse results from the test.

6.4 TEST DATA

6.4.1 A typical surge waveform recorded during the test, is shown in figure 6-5.

6.4.2 Data recorded during the pre-surge and post-surge functional tests are presented in tables 6-2 and 6-3.

Table 6-1. Surge and Cycle Test Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
1	Test Specimen	Annin Company	3611	NA	3/4-inch angle valve
2	Hand Valve	Combination Pump and Valve Co.	380-3	NA	1 1/2-inch
3	Filter	Microporous	4813F-2M	NA	2-micron
4	Pressure Gage	Ashcroft	NA	NASA 08-113-2005940P	0-to 10,000-psig ±0.2% FS Cal date 12-8-66 3-7-67
5	Pressure Regulator	Tescom Corp.	26-1002	1004	7000-psig inlet 0-to 7000-psig outlet
6	Pressure Gage	Ashcroft	NA	NASA 08-113-200594-Q	0-to 10,000-psig ±0.2% FS Cal date 12-8-66 3-7-67
7	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
8	Solenoid Valve	Marotta Valve Co.	MV-583	3696	1/2-inch, 3-way
9	Hand Valve	Robbins Aviation	SSKG 250-4T	NA	1/4-inch
10	Pressure Gage	Ashcroft	NA	NASA 08-113-200594-B	0-to 10,000-psig ±0.2% FS Cal date 12-8-66 3-7-67
11	Helium and Nitrogen Source	CCSD	NA	NA	7000-psig
12	Hand Valve	Robbins Aviation	SSKG-250-4T	NA	1/4-inch
13	Solenoid Valve	Marotta Valve Co.	MV-583	2916	1/2-inch, 3-way

Table 6-1. Surge and Cycle Test Equipment List (Continued)

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
14	Motor & Gear Reduction	Westinghouse	NA	NA	Refer to electrical schematic for identification
15	Pressure Transducer	Teledyne	176	652137	0-to 7500-psig ±0.2% FS
16	Oscillograph Recorder	C.E.C.	5-124	NASA 017887	
17	Electrical Supply	Plant Services	NA	NA	28-vdc and 115-vac
18	Switch	(See electrical schematic, figure 6-1A)			

Table 6-1A. Surge and Cycle Electrical Equipment List

Item No.	Item	Manufacturer	Model/ Part No.	Serial No.	Remarks
	Electric Motor	Westinghouse	Life-Line CSP		3-hp, 440 vac, 3-phase
	Gear Drive	Boston Gear Co.	U-145-50		1750-rpm input 35-rpm output
	Cycle Timer	Cramer Controls	523	Y2389A	115-vac 28 vdc
	Limit Switch	Honeywell	Micro-switch		28-vdc
	Time Delay Relay	ESNA	ND-12QT	J57910	(Req'd 2)
	Time Delay Relay		ND-12QT	J57909	
	Counter	General Controls	Mercury	NA	5-digits
	Switches	Und. Lab. Inc.	NA	NA	5-amp , 115-vac, 20-amp , 230-vac
	Relays	Magnetic Elec. Co.	NA	NA	115-vac, 5-amp 400 ohm

Table 6-2. Pre-Surge Functional Test Data

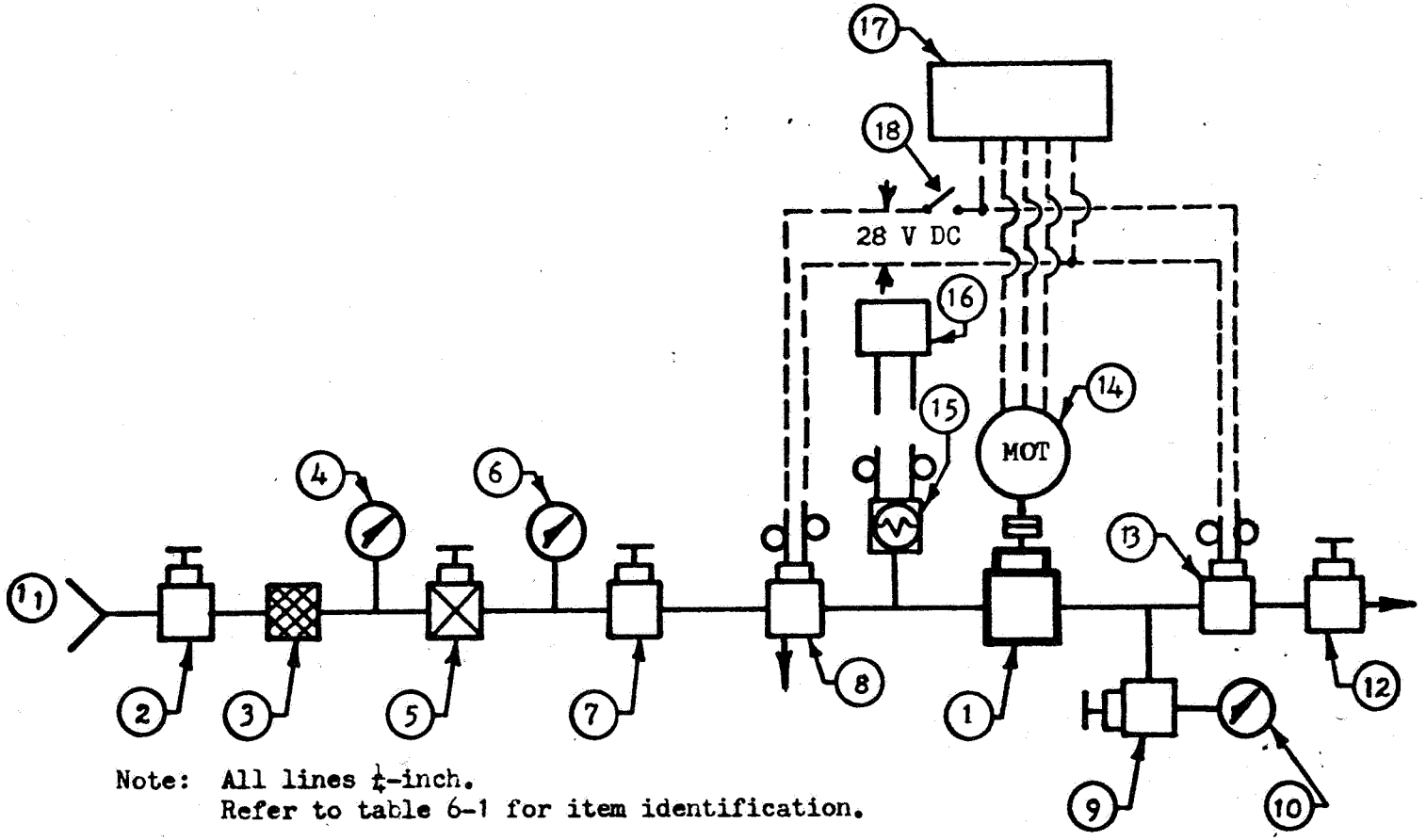
Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	50	12	17	20
	100	0	18	4	4	-
	100	2	4	-	-	3
2	100	6000	47	15	20	17
	100	0	20	5	3	-
	100	2	5	-	-	2
3	100	6000	45	15	20	20
	100	0	20	4	3	-
	100	2	4	-	-	3

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 6-3. Post-Surge Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	50	12	17	20
	100	0	18	4	4	-
	100	2	4	-	-	3
2	100	6000	47	15	20	17
	100	0	20	5	3	-
	100	2	5	-	-	2
3	100	6000	45	15	20	20
	100	0	20	4	3	-
	100	2	4	-	-	3

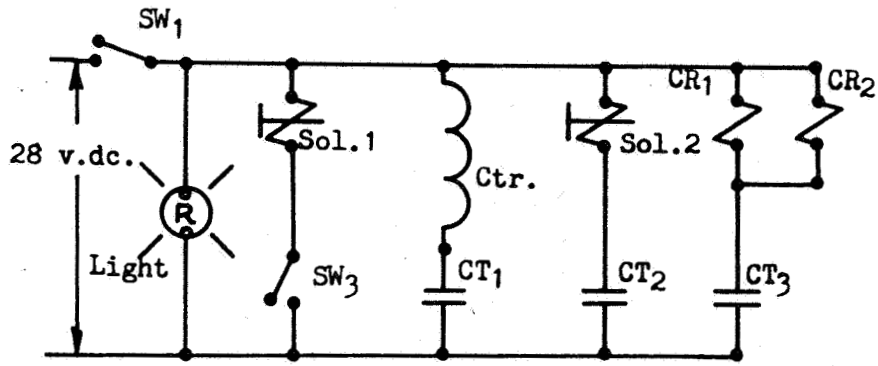
Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
	100	6000	0	0
	100	0	6000	0



Note: All lines ¼-inch.
Refer to table 6-1 for item identification.

Figure 6-1. Surge & Cycle Test Schematic

Note: Refer to table 6-1A for item identification



NOTE: CR_1-Set time to allow delay in open position and time to close valve. ($CR_1 > CR_2$)
CR_2-Set time delay for length of time necessary to open test specimen.
CT_1-Set cam to actuate once per cycle in any position.
CT_2-Cam actuates to vent during interval when test specimen is closed.
CT_3-Cam set so that SW_3 is actuated in the total time interval for opening, delay in the open position and closing of the valve.

Sol.1-Inlet pressure solenoid,3-way
Sol.2-Vent Solenoid, 3-way

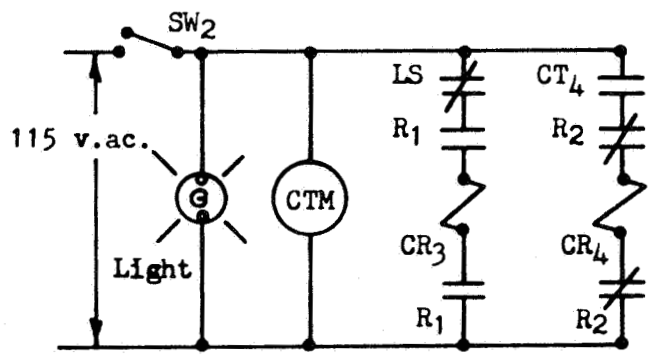
Light-Ind.light-RED

Ctr-28v.dc.counter

CT_1;CT_2;CT_3-Tips of cycle timer-N.O.

CR_1;CR_2-Time delay relay - TOE

SW_1;SW_3-28V.dc.- ON-OFF switch.



NOTE: CT_4- Setting same as CT_3.

CTM-Cycle timer motor

CT_4-Tips of cycle timer - N.O.

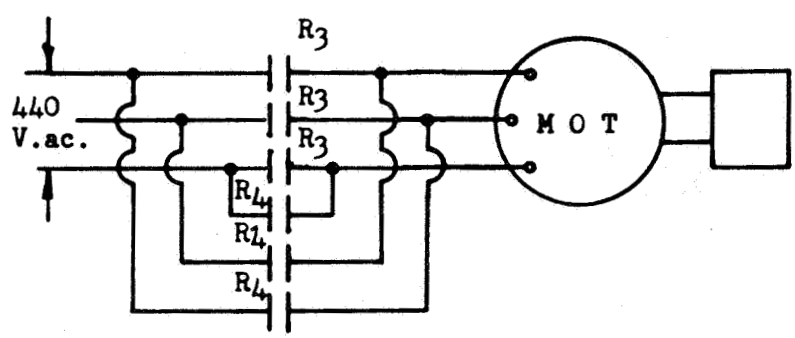
LS-Stroke travel limit switch - N.C.

R_1-Tips of CR_1 - N.O.
R_2-Tips of CR_2- N.C.

Light-Ind.light-GREEN

CR_3;CR_4-Coils of reverse contacts

SW_2-115 v.ac.- ON-Off switch.



R_3- Tips of CR_3- N.O.
R_4- Tips of CR_4- N.O.

MOT-3 hp., 440 v., 3 phase, motor.

Figure 6-1A. Cycle Electrical Test Schematic

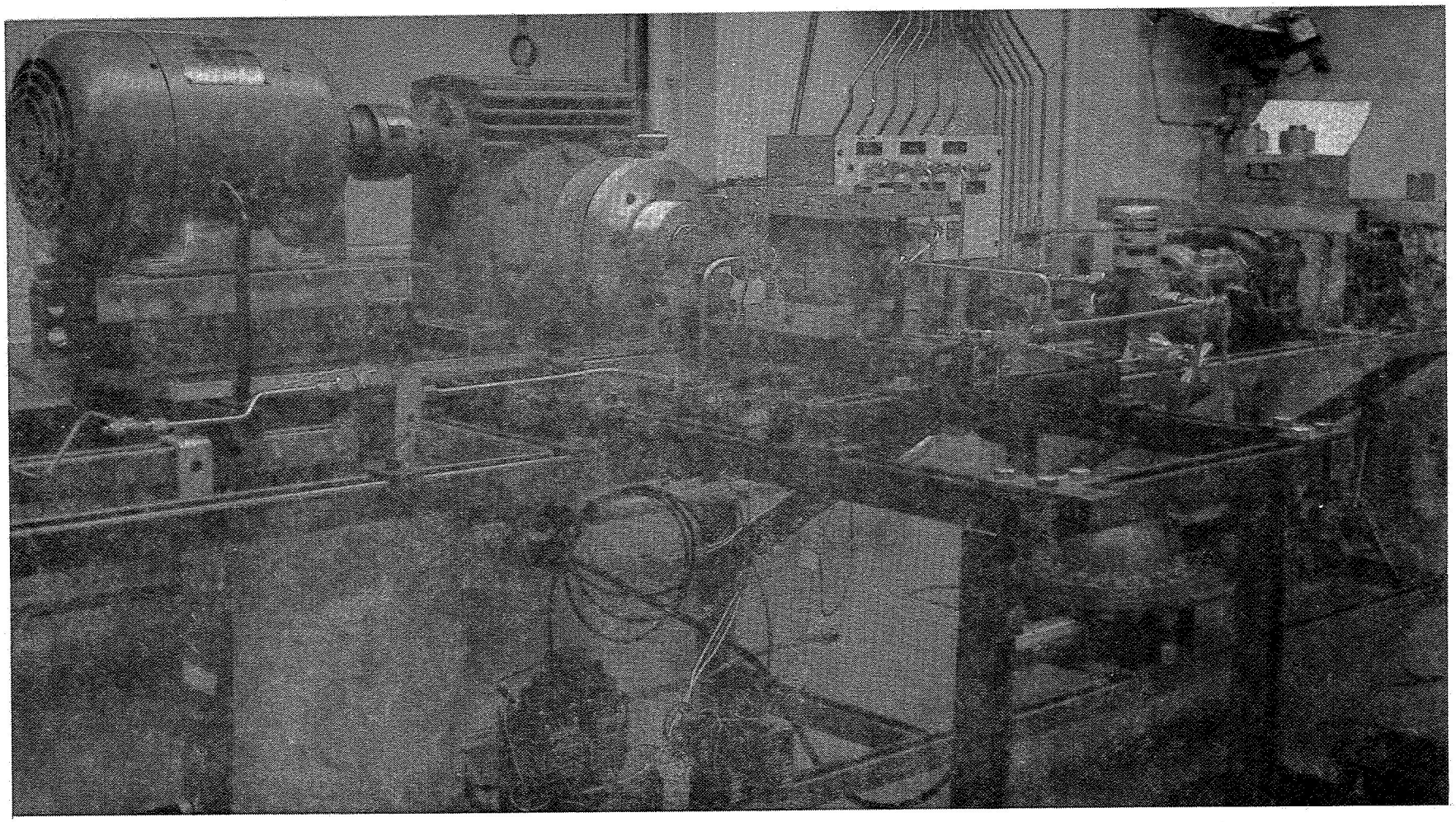


Figure 6-2. Surge And Cycle Test Setup

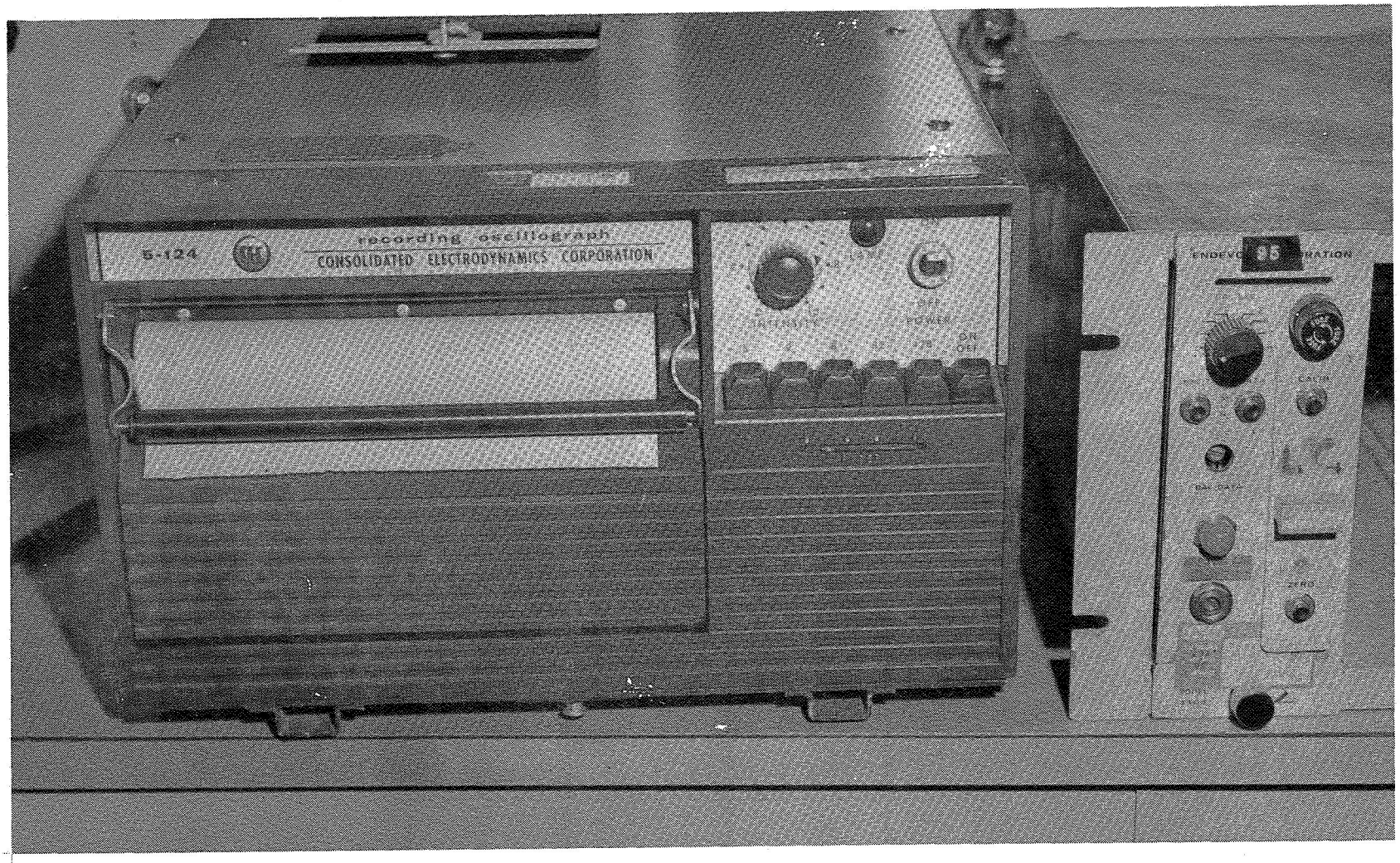


Figure 6-3. Surge And Cycle Test Instrumentation

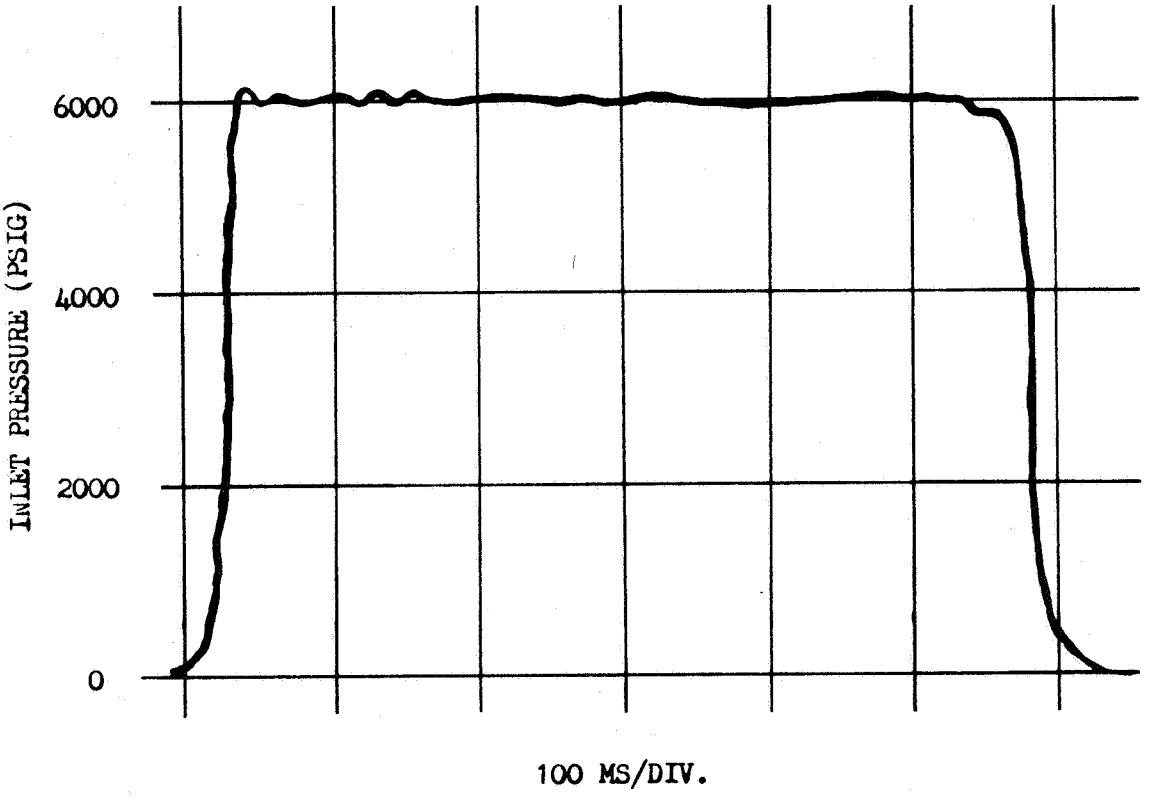


Figure 6-4. Typical Surge Waveform

SECTION VII

LOW TEMPERATURE TEST

7.1 TEST REQUIREMENTS

7.1.1 The test specimen shall be subjected to a low temperature test at -20 (+0, -4) °F to determine whether the environment causes degradation or deformation.

7.1.2 The test specimen shall be subjected to a functional test in accordance with section IV during the low temperature test using helium as the test medium.

7.2 TEST PROCEDURE

7.2.1 The specimen was installed in the test setup as shown in figures 7-1 and 7-3 using the equipment listed in table 4-1.

7.2.2 With thermocouple 19 affixed to the specimen, thermal chamber 18 was cooled to -20°F and the relative humidity was maintained at the prescribed 60 to 90 per cent.

7.2.3 Temperature stabilization was achieved and a functional test was performed.

7.2.4 The chamber was returned to ambient temperature and a second functional test was performed.

7.2.5 The specimen was visually inspected within one hour of its return to ambient temperature.

7.3 TEST RESULTS

7.3.1 The specimen demonstrated no apparent adverse effects from thermal changes except for a slight increase in the low pressure torquing values as recorded in the functional data.

7.4 TEST DATA

Data recorded during the test are presented in tables 7-1, 7-2 and 7-3.

Table 7-1. Pre-Low Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	45	10	14	17
	100	0	12	5	3	-
	100	2	5	-	-	3
2	100	6000	49	10	17	18
	100	0	13	6	4	-
	100	2	4	-	-	4
3	100	6000	47	12	18	17
	100	0	13	6	5	-
	100	2	6	-	-	4

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 7-2. Functional Test Data at -20°F

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	47	24	45	40
	100	0	22	9	17	-
	100	2		-	-	10
2	100	6000	50	23	43	40
	100	0	25	10	15	-
	100	2		-	-	10
3	100	6000	45	21	38	35
	100	0	24	10	15	-
	100	2		-	-	11

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 7-3. Post-Low Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	45	12	16	15
	100	0	12	4		-
	100	2		-	-	3
2	100	6000	39	13	16	13
	100	0	12	3		-
	100	2		-	-	3
3	100	6000	35	14	16	14
	100	0	12	3		-
	100	2		-	-	3

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

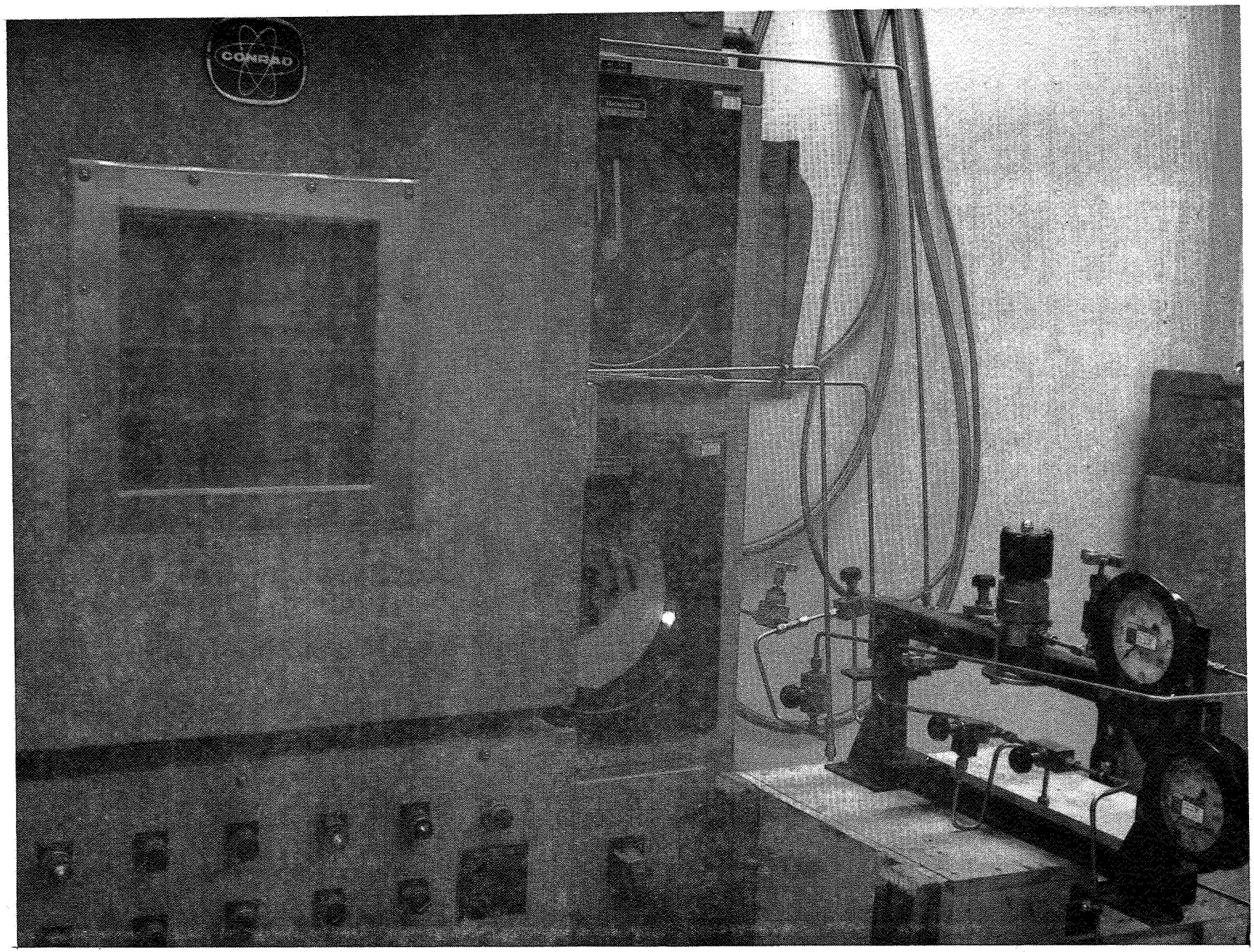


Figure 7-1. Low And High Temperature Test Console

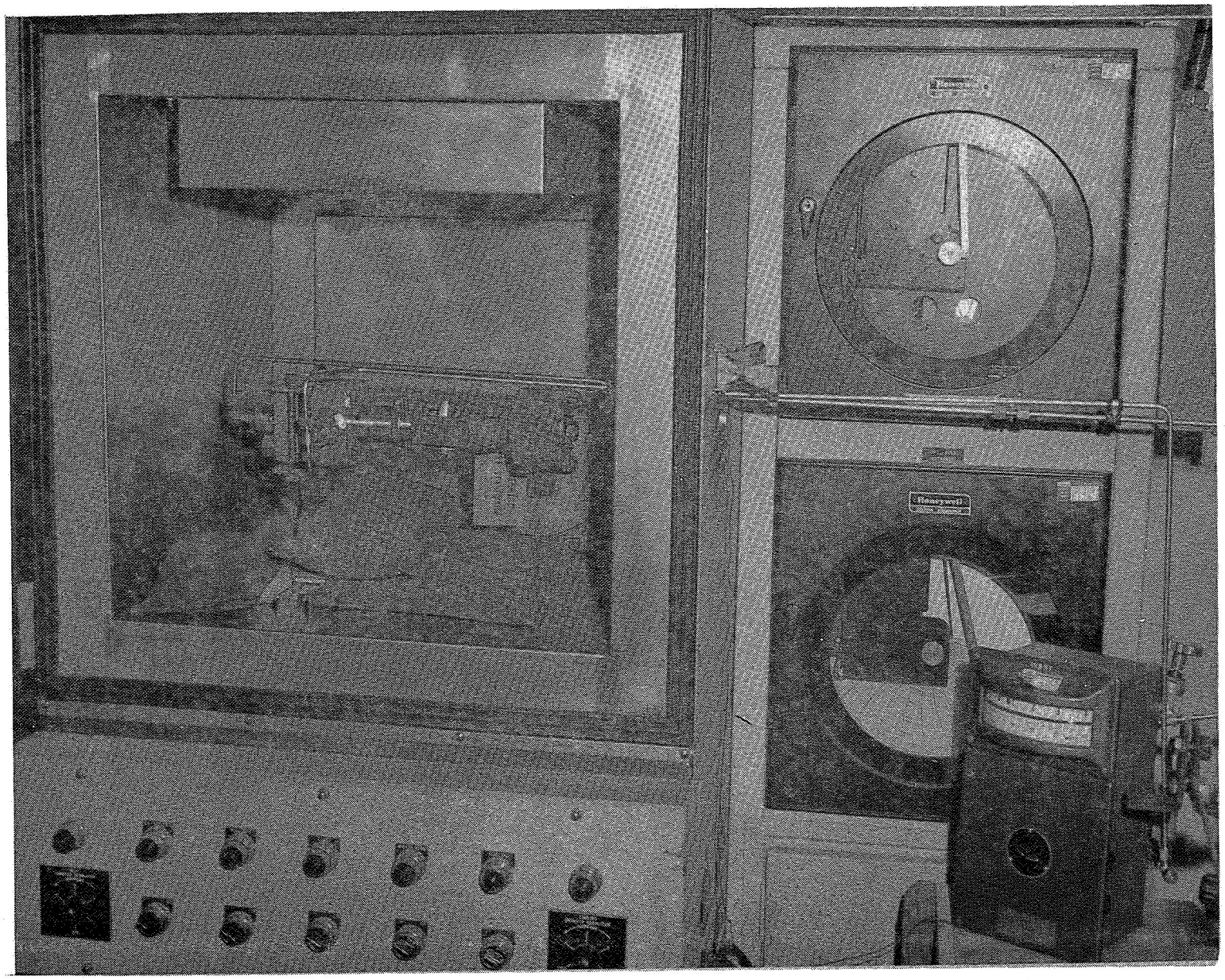


Figure 7-2. Low And High Temperature Test Close-up

SECTION VIII

HIGH TEMPERATURE TEST

8.1 TEST REQUIREMENTS

8.1.1 The specimen shall be subjected to a high temperature test at 160 (+4, -0) °F for a period of 72 (+2, -0) hours to determine if the environment causes degradation of performance.

8.1.2 The specimen shall be subjected to a functional test in accordance with section IV during and after the high temperature test using helium as the test medium.

8.2 TEST PROCEDURE

8.2.1 The specimen was installed in the test setup as shown in figure 7-1 and 7-3 using the equipment listed in table 4-1.

8.2.2 With thermocouple 19 affixed to the specimen, the temperature of thermal chamber 18 was increased to 160°F at a rise rate of approximately 1° per minute. The humidity was maintained at 20 per cent.

8.2.3 This temperature was maintained for 72 hours after temperature stabilization.

8.2.4 A functional test was performed while the specimen and chamber were at 160°F.

8.2.5 The chamber temperature was returned to ambient conditions upon completion of the functional test.

8.2.6 Within one hour following the establishment of ambient conditions, a visual inspection and a functional test were performed on the specimen.

8.3 TEST RESULTS

8.3.1 The specimen demonstrated no adverse effects from the thermal change.

8.4 TEST DATA

Data recorded during the test are presented in tables 8-1, 8-2 and 8-3.

Table 8-1. Pre-High Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	45	10	15	18
	100	0	11	2	2	-
	100	2		-	-	2
2	100	6000	42	10	19	19
	100	0	14	2	2	-
	100	2		-	-	2
3	100	6000	41	72	22	20
	100	0	17	2	2	-
	100	2		-	-	2

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 8-2. Functional Test Data at +160°F

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	42	10	16	18
	100	0	9	3	3	-
	100	2		-	-	3
2	100	6000	37	10	16	17
	100	0	8	3	2	-
	100	2		-	-	3
3	100	6000	40	11	16	18
	100	0	8	3	2	-
	100	2		-	-	4

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 8-3. Post-High Temperature Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	40	15	20	17
	100	0	8	3	1	-
	100	2		-	-	1
2	100	6000	35	15	18	18
	100	0	5	3	2	-
	100	2 2		-	-	1
3	100	6000	35	13	17	18
	100	0	5	3	1	-
	100	2		-	-	1

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

SECTION IX

CYCLE TEST

9.1 TEST REQUIREMENTS

9.1.1 The test specimen shall be subjected to 1000 cycles during the cycle test.

9.1.2 Each cycle shall consist of pressurizing the inlet port to 6000 psig and then opening and closing the specimen. GN_2 shall be the test medium.

9.1.3 The specimen downstream pressure shall be vented to below 3100 psig after each cycle.

9.1.4 A functional test, as specified in section IV, shall be performed following the completion of 50, 100, 500 and 1000 cycles.

9.2 TEST PROCEDURE

9.2.1 The specimen was installed in the test setup as shown in figure 6-2 using the equipment listed in table 6-1.

9.2.2 All hand valves and regulators were adjusted for zero pressure.

9.2.3 Hand valve 2 was opened and gage 4 indicated 7000 psig.

9.2.4 Regulator 5 was adjusted until gage 6 indicated 6000 psig.

9.2.5 The electrical network was adjusted to sequence the following events:

(a) Solenoid valve 9 was actuated to pressurize the specimen to 6000 psig as was indicated on gage 6.

(b) Solenoid valve 13 was actuated and closed the outlet port during specimen opening and closing.

(c) Reversible electrical motor 14 was operated and opened and closed the specimen.

(d) Solenoid valves 8 and 13 were deactuated and pressure from the specimen was vented to below 3000 psig downstream, as was indicated on gage 10.

9.2.6 Functional tests were performed on the specimen after 50, 100, 500, and 1000 cycles.

9.3 TEST RESULTS

The test data showed the operating torques decreased slightly during the cycle test and the torque required to hold 6000 psig back pressure increased from 100 to 300 inch-pounds. The valve operation remained smooth throughout the cycle test.

9.4 TEST DATA

The test data recorded during this test are presented in tables 9-1 thru 9-5.

Table 9-1. Pre-Cycle Functional Test Data

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	35	10	14	18
	100	0	7	2	3	-
	100	2		-	-	3
2	100	6000	32	12	13	17
	100	0	7	3	2	-
	100	2		-	-	3
3	100	6000	30	11	13	18
	100	0	8	3	3	-
	100	2		-	-	4

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 9-2. Functional Test Data After 50 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	25	7	11	25
	100	0	12	3	1	-
	100	2		-	-	10
2	100	6000	25	7	11	25
	100	0	10	2	2	-
	100	2		-	-	10
3	100	6000	25	8	12	25
	100	0	10	2	1	-
	100	2		-	-	10

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	100	0	6000	0
2	100	6000	0	0
	100	0	6000	0

Table 9-3. Functional Test Data After 100 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	15	8	10	10
	100	0	6	2	10	-
	100	2		-	-	10
2	100	6000	13	8	9	12
	100	0	6	2	9	-
	100	2		-	-	12
3	100	6000	13	8	9	10
	100	0	7	2	9	-
	100	2		-	-	10

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	300	0	6000	0
2	100	6000	0	0
	300	0	6000	0

Table 9-4. Functional Test Data After 500 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	15	5	8	8
	100	0	10	2	2	-
	100	2		-	-	8
2	100	6000	13	5	8	8
	100	0	8	2	1	-
	100	2		-	-	8
3	100	6000	13	5	7	8
	100	0	8	2	2	-
	100	2		-	-	8

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	300	0	6000	0
2	100	6000	0	0
	300	0	6000	0

Table 9-5. Functional Test Data After 1000 Cycles

Run	Applied Seating Torque (in-lb)	Specimen Inlet Pressure (psig)	Opening Torque (ft-lb)	Running Torque (ft-lb)		Closing Torque (ft-lb)
				Opening	Closing	
1	100	6000	15	5	10	10
	100	0	3	1	1	-
	100	2		-	-	7
2	100	6000	15	5	8	8
	100	0	2	1	1	-
	100	2		-	-	7
3	100	6000	14	5	9	9
	100	0	2	1	1	-
	100	2		-	-	7

Run	Applied Seating Torque (in-lb)	Inlet Pressure (psig)	Outlet Pressure (psig)	Leakage (scim)
1	100	6000	0	0
	300	0	6000	0
2	100	6000	0	0
	300	0	6000	0

SECTION X

BURST TEST

10.1 TEST REQUIREMENTS

10.1.1 The specimen shall be subjected to a hydrostatic pressure of 24,000 psig.

10.1.2 The hydrostatic pressure shall be applied simultaneously to the specimen inlet and outlet ports with the valve in the open position. The pressure shall be maintained for 5 minutes.

10.2 TEST PROCEDURE

10.2.1 The test specimen was installed in the test setup as shown in figure 3-1 and 3-3 using the equipment listed in table 3-1.

10.2.2 Regulator 15 was adjusted for zero outlet pressure.

10.2.3 The specimen and hand valves 5, 6, 8, 9, 10, 11 and 24 were opened and the system was filled with de-ionized water. All air was bled from the system.

10.2.4 Hand valves 5, 8, 9, 11 and 24 were closed.

10.2.5 Hand valve 7 was opened, and 3000 psig GN_2 was monitored on gage 14.

10.2.6 Regulator 21 was adjusted until a pressure of between 50 and 100 psig was indicated on gage 15.

10.2.7 Switch 17 was then closed. Solenoid valve 18 was opened and pump 19 started.

10.2.8 The pump continued to operate until a pressure of 21,000 psig was reached and a noise was heard from within the chamber. The pressure at this time fell off and all attempts to bring the pressure up failed.

10.2.9 Hand valves 9, 11, and 24 were opened and the system was vented.

10.2.10 All data were recorded.

10.3 TEST RESULTS

10.3.1 The specimen did not reach 24,000 psig during the burst test. failure of the valve stem packing, packing gland, and bracket occurred at 21,000 psig. See figures 10-1, 10-2 and 10-3.

10.4 TEST DATA

The specimen remained intact up to a pressure of 21,000 psig, where it showed a hesitation in the pressure during which distortion was occurring prior to the failing of the specimen.

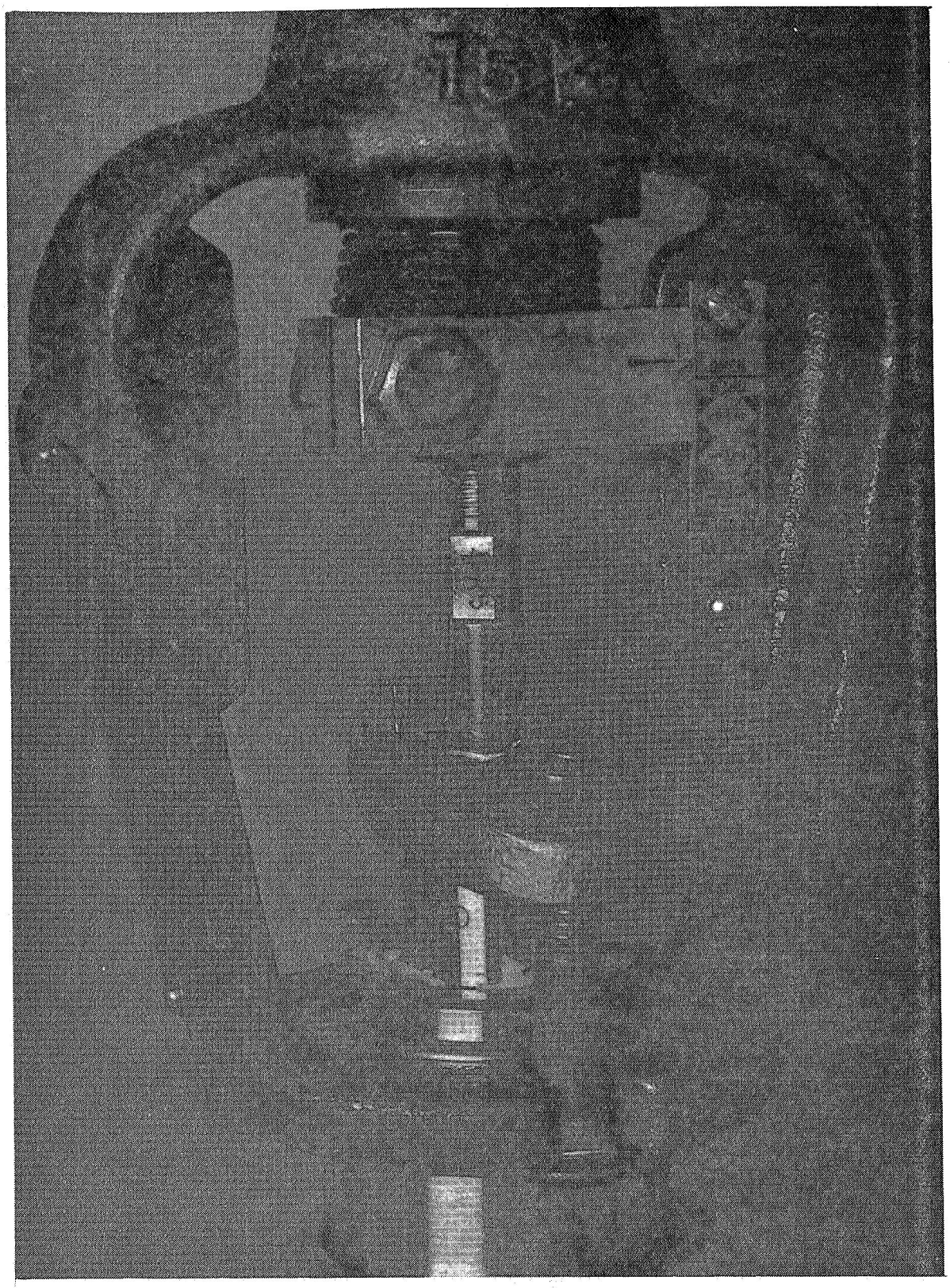


Figure 10-1. Burst Test Failure

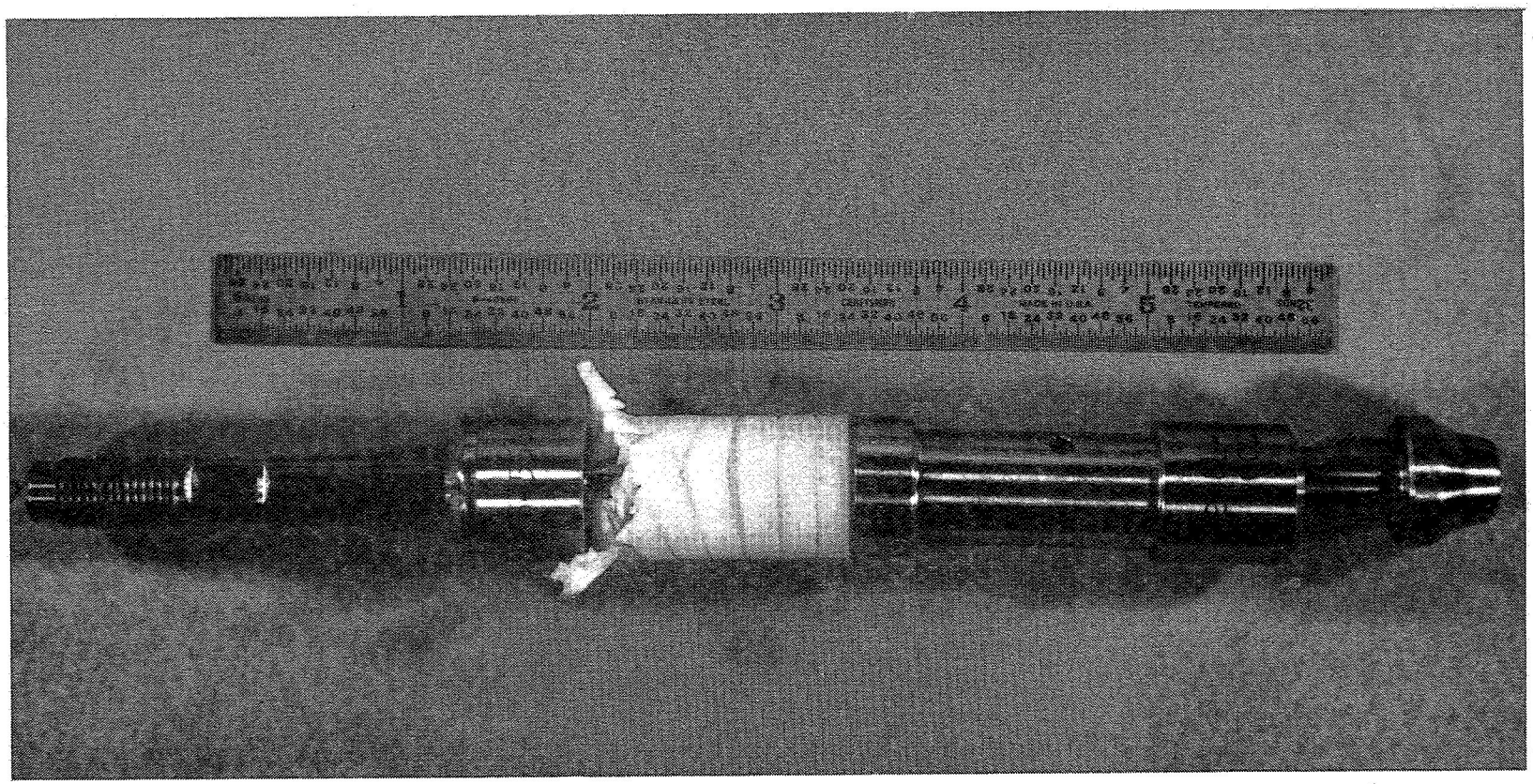


Figure 10-2. Valve Stem & Failed Seals

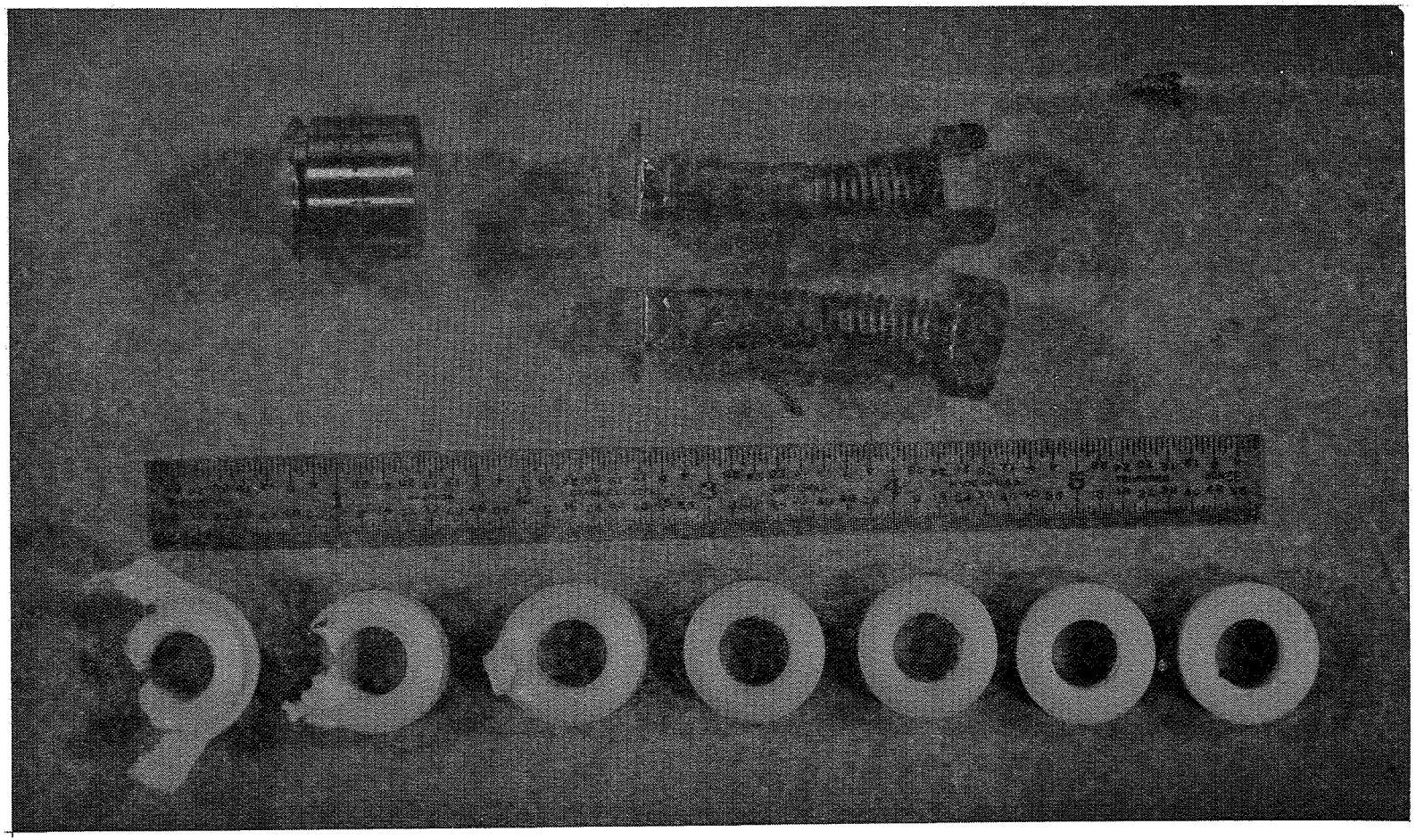


Figure 10-3. Valve Stem Seals & Retainer Bolts

APPROVAL

TEST REPORT

FOR

ANGLE VALVE, 3/4-INCH

Annin Company Part Number 3611

NASA Drawing Number 10428552

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